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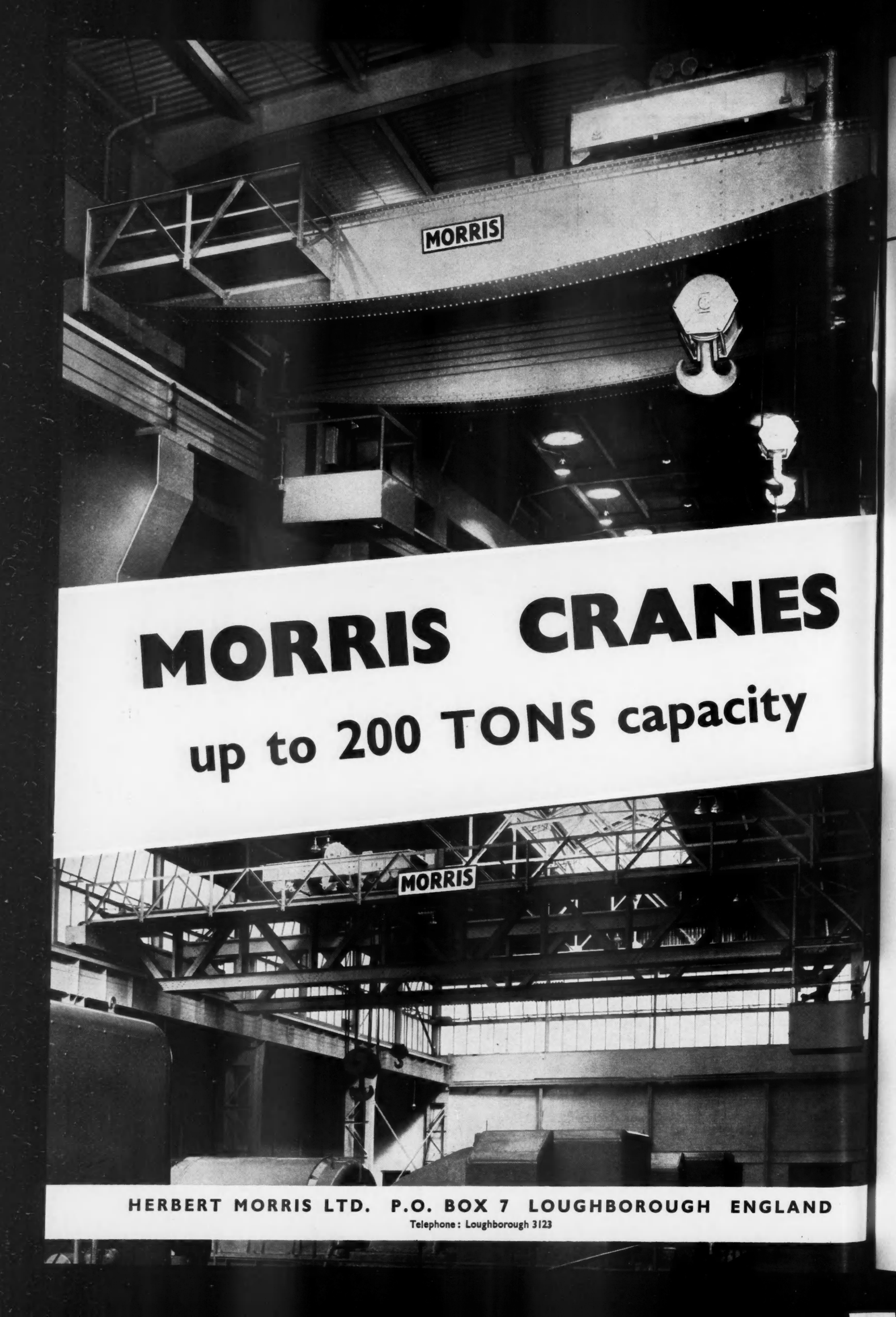
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ENGINEERING *Appointments Section faces page 612*

Memo to the Minister

IN a week or so the Durgapur steelworks will be starting up. In recognition of her substantial contribution to the project, Britain will be represented at the ceremony—not only as benefactor but as beneficiary. By helping India to stand on her industrial feet Britain can create a vast new market for her engineering goods. The forthcoming World Bank mission will likewise be an omen for British exporters, as are the gradual readjustments within the European free trade areas. It is in this world context that Britain must plan her commercial and industrial policy. What should we make? To what end should our researches be directed?

The President of the Board of Trade has recently warned the country that our exports are over-dependent on one or two products, notably motor cars, and that a dispersal of our export efforts over a wider variety of industries will be needed. At a time when the last steps of the decline of that one time giant of British industrial prosperity, the cotton industry, are being accelerated with Government support, and anxious eyes are being cast on our shipbuilding industry, now no longer the world's leader in tonnage produced, it is appropriate that a full scale examination of the place of science in British industry should have taken place. For it is now a commonplace that we shall not hold our position in world trade unless we can offer our potential customers sophisticated products based on scientific research.

The third report, *Science in Industry—Policy for Progress*, by Professors C. F. Carter and B. R. Williams (Oxford University Press), on the study instigated by the Science and Industry Committee, has now been published.

The object of research and development in industry is to increase the competitiveness and profitability of the firm. The two stages are often difficult to distinguish, but the authors are surely right that the control of research should be general and intermittent; while that of development can be more detailed and continuous. Small firms, which can undertake little or no research, can nevertheless prosper by being parasitic, both for ideas and staff, either on the research associations and universities or on their larger suppliers of materials and plant.

If the problems of research priorities are serious for industry, they are even more so for Government. These problems are both technical and economic; but so far no group containing both scientists and economists, capable of undertaking continuous and extensive study of them, exists. It will be interesting to see whether Professor Carter's recent appointment to the council of the Department of Scientific and Industrial Research leads to the formation of such a group.

The basic problem is the impossibility of this country " keeping up with the Jones's " in all the fields which require vast financial and human resources. Between all the exhilarating attractions of nuclear power systems, supersonic flight, space research and even bigger and more complicated electronic computers, we have to carve out for ourselves paths of inquiry and possible manufacture which are within our capacity and on which we shall specialise. There is the related point as to whether Government help should be concentrated, as it has mostly been up till now, on the few strong points of advancing engineering or should be spread over the weak points of many industries.

Undoubtedly there is a case for massive Government support to achieve a technical breakthrough in a field beyond the resources of private industry; for instance atomic power. But if we are to have a greater variety of scientifically based export industries, help may well have to be given to some industries which appear today to be caught in the net of their own backwardness.

The methods of Government support may be of many different kinds: ranging from adjustments in fiscal and financial policy to the setting up of State development bodies on the lines of the National Research Development Corporation. Frequent changes in the former are undoubtedly harmful to technical advance and stability may be more important than the actual level of taxation or bank rate. On the other hand, some taxes, such as purchase tax, must have a distorting effect on demand and production and so on the incentive to technical change. Further help might well be given to small firms which are capable of making substantial advances in some modern technologies. This could take the form of a higher level of freedom from profits tax or, as recommended by the Radcliffe Committee, insurance by Government against the risks of providing capital for adventurous innovations.

Professors Carter and Williams are sceptical as to the existence of any Government policy on the application of science to industry. Maybe this report will stir the new Minister for Science to bring some cohesion into the present multi-headed administration of scientific matters in Government. Meanwhile, a few wide-awake firms in the really advanced industries—such as automatic control and automation—are going ahead very nicely, without thanks to the Government.

XUM

Cover Picture.—*Production testing a Vulcan nose undercarriage for steering angle. The rig is adaptable for a variety of undercarriages by changing holding brackets. Hydraulic power is obtained from the mobile test rig in the foreground.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

Physical processes have a way of adjusting themselves to changed circumstances. People don't. But people could learn a thing or two from engineering processes. By getting through the humdrum jobs in a clean mechanical way we should have more time left for living. I am afraid that we shall soon spend so much time moving from one place to another that we shall have little time for working and none for leisure.

Perhaps it would be useful to look at the traffic problem in the light of natural processes—say flow through a venturi tube. When the fluid comes to a constriction, it simply accelerates. But what happens in the streets of our cities? If there is an obstruction are we encouraged to accelerate? The sign says "slow down" and adds "danger" to reassure us. Why not remove the threat and say: "Constriction ahead—speed up."

Then there is the motorway. In first-year engineering courses we learn about relative velocities. For instance, if a madman drives a racing car at 157 miles per hour—the record at the time of writing—and passes a string of vehicles that travel at 50, the relative velocity is 107 miles per hour. In our cities we only seem to tolerate a relative velocity up to 30 miles per hour for traffic moving in the same direction and 60 for opposed traffic. Separating streams of vehicles by a thin white painted line will comfort only those who put their faith in the divine infallibility of motorists. Friction in these conditions is likely to generate more than heat.

Finally, London Transport makes a determined attempt to accomplish the impossible: countercurrent mixed flow. No attempt is made to hold back passengers about to embark in a tube train until those wishing to leave have managed to escape; the result is something like the thermal motion of atoms at 1,000° K. The system only works because of the passenger's square-jawed determination to get home. But is it sensible?

Subway cars are conveniently equipped with doors on both sides, port and starboard, but the layout of even the most crowded stations ensures that only one side can be opened at a time. As a result, rush-hour trains spend a third of their time at stations. With present train density, short of digging new tubes the only way to increase capacity is to reduce standing time. Charing Cross station at 5.30 p.m. gives the impression that the train's chief function is not to transport people but to act as a leveller of social differences.

CAPRICORN

Weekly Survey

Go North Young Man

If the effects of the motor industry's further expansion plans are to be felt by even the 1962 models, then the question of where the new capacity is to be housed is not to be put off much longer.

Compulsion may not be in the Government's mind but through the Board of Trade's development licences it is able to say no, if it so wishes, to an application by Ford's to spend their allocated £50 million at Dagenham, or by the British Motor Corporation to invest its £49 million at Longbridge and Cowley. The planning situation at Luton in relation to Vauxhall's major development scheme is rather less clearly defined.

Scotland is on the way to a sharp improvement in its steel supply position and Mr. Macmillan and Mr. Eccles have promised to do something about local unemployment, on which the Scots are unwilling experts. The economic arguments for a Scottish motor car industry are strong in terms of locally available labour, whose trade union leaders are not pressing for rates of pay equal to those of the Midlands. Materials are to be available and the Clyde and the Firth of Forth are there for ready shipping outlets for export.

But the motor companies have indeed to look abroad for a larger and larger percentage of the sales of their rocketing output. Sir Leonard Lord already has his sights on a million vehicles a year from BMC alone. The accountants obviously hold definite views on the effect on costs of keeping the whole development within one integrated unit. Taking a car industry to Scotland may provide much needed employment, the cars still have to be sold abroad on a market in which price is a vital factor.

There is one inducement which may lead the car companies to overcome latent reluctance to cross the border. If the Government used its new powers and paid the 85 per cent grant it has empowered itself to make where the final value of a factory is less than it cost to build, as happens in the under-employed areas, then the car firms could spend a higher proportion of their savings on new machinery, gaining a useful help from the Government. By taking work where it is needed they would be recouping also in gaining what might prove to be a highly loyal labour force.

Locomotive Markets

Sir George Nelson, in his capacity as president of the Locomotive and Allied Manufacturers' Association, pointed out at the first showing of the COI's film "British Locomotives" an unexpected way in which British Railways modernisation is helping this country.

That the modernisation schemes, as they come into effect, speed up the transit of raw materials to the factories is well enough appreciated, and Sir George paid tribute to the railways' efforts in that field and also in shifting the finished products to the docks for export. He went on to draw a comparison with the motor car industry and with heavy electrical engineering, both successful in exporting and both based on high and stable home demand.

The locomotive industry was no exception to the need for a stable home market as the basis for successful exporting and they were grateful to the British Transport Commission for giving them the opportunity of joining the modernisation programme. The association's president looked to further collaboration and pooling of technical knowledge between British Railways and industry which would lead to the production for export of British standard locomotives, so keeping Britain in front in progress in this field.

Next October the BTC is holding an electrification conference and exhibition and has invited delegates from railways abroad to come and see what problems are being encountered, and how they are being overcome, in the development of a.c. electrification. Sir George described this as a most important part of the Commission's activities in assisting in the solving of problems overseas.

Insuring Tractors and Jets

One of the mirrors of technical change is insurance. In aviation, insurers face the problem of larger, faster, more expensive aircraft; the same number of people being carried in fewer planes. It is this situation, the value of the unit insured rising rapidly and the spread of the risk falling almost as fast, that led Mr. Alan B. Hunter, the principal surveyor of the British Aviation Insurance company, to tell the Insurance Institution recently that there is a case for raising rates charged to jet airliner operators. If losses in the big jets were no more than the four in every hundred of the best piston engined types the cost would be $20 million for every 100 aircraft, taking only the hull values.

With Rolls-Royce able to report at the recent handing over of Comet 4Bs to British European Airways that there has never been a loss of engine power by their Conway engines in service with the Comets, it may be that a more optimistic view will come to be taken.

At ground level the Massey-Ferguson agricultural machinery manufacturers have announced the first specialised insurance policy for agricultural machinery and industrial equipment. A firm of brokers, after investigating the design and performance of the company's equipment, have arranged with an insurance company for a policy which covers Massey-Ferguson tractors, self-propelled combines and industrial tractor-digger-shovel units. The departures in the new arrangement include all authorised uses, instead of the familiar additional premiums, and approved distributors or dealers can begin repairs without waiting for authorisation from the insurance company. As the number of holiday and week-ending cars roving the country roads increases the unlimited indemnity against third party liability, and the cover against loss or damage to equipment, will become increasingly important.

A Massey-Ferguson official in Coventry told ENGINEERING that the new policy applied to equipment already bought and not only to new machinery.

Predictions of increases in premium rates are common enough but in this case the insurance company have guaranteed that the rate now operating will stay as they are until at least the end of November, 1962.

More Houses, Larger Debts

The total hire purchase debt in Britain is well on the way to becoming double what it was a year ago. The total at the end of October this year was £807 million (October, 1958, £490 million). The October amount added to the hire purchase debt was £23 million.

Whether a lessening in the boom in consumer durables is with us or whether it was just a breather before the Christmas spending spree the £23 million of October was £5 million less than the £28 million of September. The month's addition of debt to finance houses, mostly for motor cars, was the same as the preceding months although not up to the levels of the earlier months in the year.

The hire purchase debt owed directly to household goods shops is now £299 million.

In housing the monthly completion rate is now

almost high enough to sustain an annual rate of 300,000 houses built. The October figure was 26,303 completed in Great Britain. 225,102 houses have been built up to the end of October this year against almost 2,000 more up to the same date last year.

Europe's Need of America

America should join the Organisation for European Economic Co-operation and help to prevent an outright split between the Common Market and the Outer Seven. This is the opinion of Mr. Alfred C. Neal, president of the United States committee for economic development.

The threatening division is seen by Mr. Neal as weakening the West in economic competition with the Communist world. This is not quite the view of Professor Hallstein, President of the Commission of the Common Market, who has already put forward a suggestion for cooperation between the Common Market and other European nations in helping under-developed countries.

But Mr. Neal feels that the danger he sees ahead could weaken the efforts Europe could make, which are needed to assist America in helping the newer countries, as Europe, he recalls, once needed the United States to help in post-war reconstruction.

Mr. Neal urges that as the Common Market powers reduce their internal tariffs so they should lower the discrimination against all outsiders. The United States should join OEEC and help to convert it into an Atlantic economic alliance, handling problems of concern to all the Western states.

While Mr. Neal has been taking the broad view Finland has disappointed the hopes that she would come into the Outer Seven. Her Government has informed the Finnish parliament that there is no possibility of joining in full membership at this stage. Significantly the statement was made only three days before a Finnish trade delegation set off for Moscow. Indeed, the specially delicate commercial-political position of this tiny state on the edge of the Russian border and the Polar regions was mentioned in the Government's message. But a form of associate-membership was not ruled out and an arrangement in this form may eventually be made.

Training Scheme Grants

The Cotton Board, the Booksellers' Association and the Hotel and Catering Institute are the first to receive grants from the Industrial Training Council towards the development of training schemes.

The first three grants by the Council from the £75,000 Government grant-in-aid is to provide for three years half the salary of an assistant to the present training officer at the Hotel and Catering Institute and half the salary and expenses of training officers to be appointed by the Cotton Board and the Booksellers. If at first thought it appears that only one of the Council's three grants is industrial in character it is fair to observe that both catering and the activities of the book trade are of importance to those in industry.

The new system of craft certificate examinations introduced by the City and Guilds of London Institute is having its effect. The national apprenticeship scheme of the National Joint Council for the building industry has been revised to bring it into line with the requirements of the Institute. The effect on the courses will be a tightening up of their relation to the demands made on the students when they enter industry and to the changes taking place in the companies they will join.

A shortage of apprentices for the building industry has been pointed out by Sir Richard Coppock, general secretary of the National Federation of Building Trades Operatives. Sir Richard claims that the building industry offers as good a career as "black coated occupations." He may be right, but the prevailing opinion with the public may well still be conditioned by the subsistence wage rates of before the war, the uncertainty of assured employment and the ease with which devices like the credit squeeze can throw building craftsmen out of work. Not a little value will be obtained by the building industry as a whole becoming more aware of the advantages of research and being quicker in passing on new developments.

Cable and Countryside

The power transmission cables of this country could be put underground at the cost of a 15 to 20 per cent increase in the price per unit. But would the consumer pay this to avoid the use of overhead transmission lines?

Both statement and question were put by Sir Christopher Hinton, chairman of the Central Electricity Generating Board, when he spoke at the Royal Society of Arts on "Power Production and Transmission in the Countryside: Preserving Amenities."

Sir Christopher tackled the central problem when he described the United Kingdom as supporting 50 million people on an island "designed for 20 million" and seeking continuous improvement in material standards. This could not be done without the growing industrialisation absorbing areas formerly rural in character. The exposure of proposals to the criticism of the public through ministerial inquiries, remembering that power lines and stations had to exist somewhere, was perhaps the only way of evolving a balanced policy.

Coming to the most controversial problem, after the siting of atomic stations, Sir Christopher said the cost for each mile of 275,000 volt double-circuit overhead line was £25,000. Each mile of underground cable with similar capacity would cost about £400,000. Such putting underground of the transmission would eventually double the annual capital investment of the Generating Board and from this Sir Christopher derived his unit cost increase of 15 to 20 per cent. Even if this were willingly borne, could the capital be found? The capital would, by present methods, have to come from Treasury advances bearing interest, and Sir Christopher naturally enough doubted whether more taxation would be welcome.

Pious hopes that research might bring the cost of underground transmission lines down to the cost of overhead cable were quickly ruled out by Sir Christopher. Overhead lines used air as an insulator and nobody was going to find an insulator cheaper than that.

The CEGB's chairman explored with considerable sympathy the basis of opposition to the siting of power stations and lines. For policy reasons the nuclear power station site would be isolated and for that very reason important to the man seeking week-end escape from the busy urban life. "The man who fishes from Dungeness beach does not worry that Dungeness is featureless. In an easterly wind he feels he is exposing himself to the natural forces he had lost. It is useless to claim that a nuclear station will provide a dominating and challenging feature. The man who now goes there does so because nature alone challenges him there; the last thing he wants there is a challenge from man."

Sir William Holford, doyen of town planners and a part-time member of the CEGB, said, at the same meeting, that however good the design it was not going to lessen the fact that power station and the pylon were themselves the cause of the offence.

But the school of criticism which held that no use lay in design, and that all lines and power stations should be buried underground, was adopting a disastrous attitude. Technical challenge and the sense of aesthetic responsibility produced structures such as Telford's Pont Cysyllte aqueduct, Brunel's bridge at Saltash, the Wharncliffe viaduct and Bristol station.

Letters to the Editor

THE ARCHITECT HAS PRIME RESPONSIBILITY

SIR, Few will quarrel with Mr. Jefferiss Mathews in his plea, under the above title, for a greater degree of collaboration between architect, engineer and builder (ENGNG., 27 Nov., p. 543).

To state, however, that "engineers lack . . . an appreciation of design" is a generalisation which does less than justice to structural engineers. With the degree of design freedom made possible by the use of welded steelwork, reinforced and prestressed concrete, and the use of the continuous frame, a new generation of structural engineers is springing up who are certainly not lacking in a design sense.

In the case of engineering structures, therefore, such as bridges, and buildings for heavy industry, Mr. Mathews must not be surprised if the structural engineer is sometimes called upon to lead the team.

Yours faithfully,

A. V. HOOKER.

240 Cyncoed Road,
Cardiff.
30 November, 1959.

DESIGNING FOR SULPHURIC ACID

SIR, We agree with and thank you for the calculation of the number of permutations of equipment choice relating to our brochure entitled *Sulfuric Acid Contact Plants* (ENGNG., 4 Dec. '59, p. 588).

The figure of "over 750" permutations was calculated at an early stage of this preparation, when it had been intended to include another flap over the "oleum" section illustrating the alternative of an oleum bubbling tank which we use when plant capacity is small or when the oleum production requirement is a fraction of the total H_2SO_4 capacity. This flap was omitted in the final form of the brochure.

ENGINEERING calculation:

$2\times1\times2\times2\times1\times3\times2\times3\times2\times2\,(9\times64)=576.$

Chemico calculation with bubbling tank for oleum:

$2\times1\times2\times2\times1\times3\times2\times4\times2\times2\,(12\times64)=768.$

There are, of course, many more possible permutations as every change in equipment or process step gives another multiplying factor. For example, the byproduct steam from the process can be used to drive the air blower, so saving power, heated air from the converter can be supplied to the sulphur furnace, and so on.

We feel that this brochure will bring home to everyone who reads it the importance of the experience in a given field of a contractor offering a process for a specific duty; experience which can pay dividends in the acquisition by chemical manufacturers of a plant designed to their needs to yield the product at the lowest cost.

Yours very truly,

E. L. WYATT,
Advertising Manager.

Chemical Construction (G.B.) Limited,
9 Henrietta Place, London, W1.
7 December, 1959.

ENGINEERING FOR FOOD

SIR, Your recent leading articles on food production highlight many of the serious problems facing those of us who serve this great industry. You deserve not only our congratulations for the courage you have shown in this matter but also our gratitude for the helpful lead you have given to the industry.

While these mighty problems face the food industries of all countries, it is true to say that Britain is particularly vulnerable. Our own natural resources are far from adequate to meet the food requirements of our vast and growing population. Much of the raw material required

Continued on the next page

for our industry and intended either for direct manufacture or for feeding and maintaining food-producing animals has to be imported. Thus, the finished food product reaches the shops at a price directly related to its world market price, with little room for flexibility. Moreover, in times of world shortages there is virtually no possibility of completely supplementing, by home production, shortages arising on the home market. An example of the resulting situation has been seen recently in the violent fluctuations in the price of butter. These imports can only be obtained in return for exports, so that, if ever the time should come when export markets for our home-produced goods dry up, or even diminish, then our food industry and our people will indeed have a lean time.

It is therefore vital that the raw materials for our industry be handled with the greatest efficiency. It follows that more and more engineering will be required in the industry so that the food technologists can see a fruitful application of the new techniques they constantly seek and perfect.

The industry seems to be made up of three main branches. First, that which concerns itself with the production of the raw materials; secondly, a large manufacturing branch whose task is to convert these raw materials into attractive foodstuffs of many kinds; and thirdly, a branch, which overlaps the second to some extent, but which is mainly concerned with the packaging, storage and distribution of these foodstuffs to the public. In all three branches much engineering plant, both chemical and mechanical, is already in operation, but there is room for much more development on such lines.

In that section of the industry, the milk industry, with which I am directly concerned, we have our own special problems. For example, it is not possible, because of climate conditions and for other reasons, to produce milk in this country as cheaply as in some countries abroad. It is obligatory for the industry to produce sufficient supplies to satisfy all home demands for liquid milk. To achieve this there must always be a surplus at certain times of the year and this surplus becomes the raw material for the manufacture of milk products of many kinds.

Unfortunately, the size of this surplus seems to be almost unpredictable for any one year, and not infrequently large manufacturing plants are fully occupied for only very limited periods in the year. This tends to discourage development and the installation of the necessary engineering plant which could introduce greater efficiency to the industry. It is not easy to find an answer to this difficult situation, but some workers believe that the solution may be found in a milk synthetically produced from the very materials that the cow utilises so naturally but not necessarily with maximum efficiency. Reports of American work on this topic have already appeared in the literature.

One other important point which must be mentioned is the urgent need for the recruitment of promising youngsters to the industry. Newcomers of this calibre are proving more and more difficult to find and to attract to the industry. One is almost forced to the conclusion that our present expensive education system can be likened to a gigantic homogeniser which so thoroughly treats the youth of this country that there is now less chance for the "natural cream of human ability" to rise to the surface.

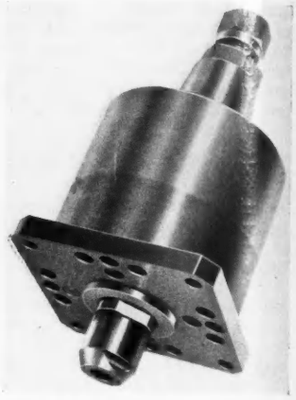
The years that lie ahead could be very difficult ones for our food industry and these difficulties can only be minimised by an earnest drive for greater efficiency. Most of the larger firms engaged on food production are quite clearly well aware of the situation and are taking, wherever possible, appropriate action. They will be greatly fortified and encouraged by the attitude you have taken up.

Yours faithfully,
W. G. WEARMOUTH.

National Institute for Research in Dairying,
The University, Reading.
2 December, 1959.

New Plant and Equipment

AIR TURBINE
Free Speed 35,000 r.p.m.



A RANGE of air turbines has been introduced to meet the demand for a powerful, relatively high speed unit. The Turbodynes will develop up to 1·9 h.p. at 25,000 r.p.m.

The design of rotor has allowed a governor to be used to limit the free speed to 35,000 r.p.m. with an inlet pressure of 100 lb per sq. in. An additional overspeed safety device is also incorporated that will take over in the event of governor failure.

The units are cylindrical with a rectangular base plate and three alternative shaft ends. These are an integral collet; interchangeable collets; and parallel keyed shafts. Each can be for clockwise or anti-clockwise rotation. The air inlet is coaxial with the turbine centre line.

The workshafts are carried in ball bearings which are end loaded to 30 lb in order to eliminate backlash. The exhaust is through the base plate in the standard models but alternative arrangements can be used to suit customers' requirements. The four units develop powers ranging from 0·5 to 1·9 h.p. at air pressures of 100 lb per sq. in. They weigh 4¼ lb and the bodies are 3½ in diameter. Chief claims are that they are robust with a high power to weight ratio and that the workshaft is separate from the rotor shaft. *Turbomachines Limited, Station Road, Dorking, Surrey.*

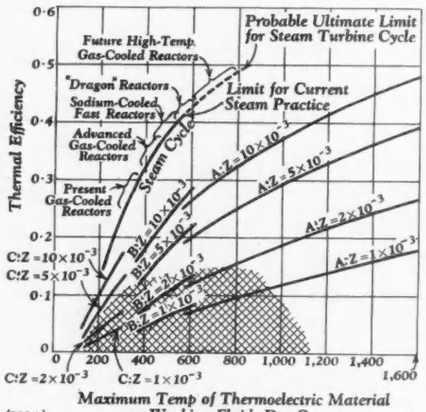
SILICON RECTIFIERS

THE Y series of Sarkes-Tarzian silicon rectifiers are rated at 250A d.c. (half wave) with 50 to 400 peak inverse volts. Low thermal drop (less than 10° C) junction to base and low junction temperature rise (approximately 60° C) are built in features. Either positive or negative base polarity is available. Stud base mounting. *Ad Auriema Inc., 85 Broad Street, New York, NY, USA.*

THERMOELECTRIC POWER

SIR, We are in substantial agreement with your correspondents Mr. K. H. Spring and Mr. D. T. Swift-Hook that the achievement of high figures of merit at high temperatures will require a major breakthrough in new materials (ENGNG., 6 Nov.'59, p. 431). It should be remembered, however, that the study of materials suitable for generators has been proceeding for, perhaps, ten years and that research and development effort in this field has become considerable even more recently. Prototypes of a few watts output have been built and we may expect 5 kW units in the United States next year.

It has been shown theoretically by A. F. Ioffe, in *Semiconductor Thermoelements and Thermoelectric Cooling* (Infosearch Limited, London, 1958) that the figure of merit, Z, can be approximately proportional to powers of the absolute temperature T: T^4, T^3, T^1, T^0, $T^{-\frac{1}{2}}$ or $T^{-\frac{3}{2}}$. In practice, it seems that only figures of merit proportional to T^3, T^1, T^0 and $T^{-\frac{1}{2}}$ have been observed for solid-state devices, whereas your correspondents' constant value of ZT implies that Z is proportional to T^{-1}. At temperatures higher than 1,100° K it is possible to exceed the efficiencies implied by the quoted "Z T = 3" limit by using a vapour phase or plasma, since such a gaseous component is completely non-degenerate.



A = water-cooled and moderated reactor with thermoelectric fuel elements
B = sodium-cooled fast reactor with external thermoelectric generator
C = organic-cooled and moderated reactor with external thermoelectric generator
Shaded area shows range for present thermoelectric materials (solid state)

Thermal efficiency (based on electrical power generated) of nuclear steam cycle and nuclear thermoelectric generating systems.

Most of the research effort, particularly in the United Kingdom, has been devoted to materials having optimum performance at low temperatures, which would be used for thermoelectric refrigeration. The class of materials studied, typified by bismuth telluride, is certainly not suitable for operation at temperatures above 300 to 500° C.

By controlling the properties contained in Z it is possible to vary the temperature at which a semiconductor material achieves its highest Z and, by using materials thus optimised to cover particular ranges of temperature in a cascaded generator, there is a good prospect of obtaining high overall efficiencies.

The graph reproduced here shows, for maximum temperatures of up to 2,000° C, the potential generating efficiencies as a function of the thermoelectric figure of merit, for several reactor systems. Superimposed is the range of efficiency achievable with present materials.

For large-scale power generation it is likely that the only system worth pursuing is a nuclear reactor in which the nuclear fuel elements themselves have suitable thermoelectric properties. Such an arrangement would lead to a simple reactor with low capital cost.

Yours faithfully,
G. W. WILSON.

Westinghouse Electric Corporation,
Pittsburgh, Pennsylvania, USA.

B. C. LINDLEY

C. A. Parsons and Company Limited,
Nuclear Research Centre, Newcastle on Tyne 6.

HONE
Straight or Cranked Shafts

A NEW lathe tool is now on the market, designed for honing straight or cranked shafts.

Called the Lathe Hone the tool is an addition to the range made by Nicol and Andrew. Four basic sizes are made —A, B, C, and D—covering respectively shaft sizes from 2 in to 4 in; from 4 in to 6 in; 6 in to 9 in; and 9 in to 12 in. The size of the lathe bed is the only limit to the length of shaft on which they can be used.

These hones are not motorised and consist of a split head in which are mounted the four abrasive stones held in shoes. The head is clamped round the workpiece after the latter has been set up in the lathe. A centre spindle attached to the hand screw adjustment passes through the main support rod, permitting finger tip control of the pressure applied to the workpiece through the abrasive stones. For mounting in the lathe the main support rod is fitted through a sleeve (not shown on the illustration) which is pivoted on a secondary rod

working within a sleeve block on the tool post.

By this arrangement the hone will automatically follow the throw of a crankshaft as it revolves in the lathe while still under the pressure control of the operator. The secondary rod being held firmly in the sleeve block allows lateral stroking movements to be made along the workpiece.

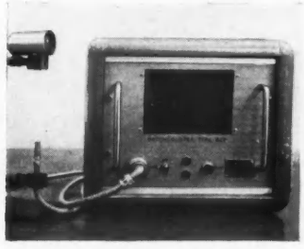
It is particularly claimed that the tool is suitable for super finishing straight, cranked or multi-diameter shafts and will appeal to the smaller operative by reason of its low cost. It is stated that the finish obtained is equivalent to that of more costly power driven tools. The firm also make a range of motorised hones which can be used on shafts up to 24 in diameter with very little dismantling. *Nicol and Andrew Limited, 20 Kelvin Avenue, Hillington, Glasgow, SW2.*

BATCH COUNTER
10 Programme Capacity

TYPE BCP batch counters will accept up to ten programmes simultaneously.

A typical example is where a conveyor delivering the parts being counted has to be slowed down as the final ones arrive. With this unit it would be possible to set the pre-impulse programme to operate at, say, ten units before the completion of the batch, the number of which would have already been set up on another programme. When there are only the ten units left to arrive, the pre-impulse signal would slow down the feed so that the count could be exact, and when the final number was reached the feed would be cut off.

The BCP unit has a speed range of up to 2,000 counts per second and the count is displayed on the decade plug-in units by illuminated numerals. The batch count can be set in units from a minimum of two to the total of the final decade in the series. The count is



made by an impulse from a photocell, microswitch, or any other electrical source giving an impulse, and the output can either be used to close relay contacts and so operate a solenoid, or it can be used directly for any controlling apparatus.

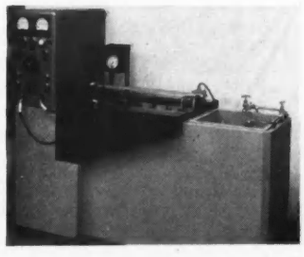
The new unit forms part of a range of general purpose instruments for batch counting articles at rates up to 20,000 per minute. It is similar in general design to others made by the firm but differs in the provision of the ten programme settings, a feature that is not present in other members of the range. *Electronic Machine Company Limited, Mayday Road, Thornton Heath, Surrey.*

PLATING BATH
Precise Thickness Control

THE chromium plating unit illustrated is for the Veriform process which it is claimed will produce a layer that can be controlled to within 0·0001 in.

The standard unit will accommodate up to 50 sq. in of plating surface at any one time. Larger sizes can be supplied. It is particularly claimed that the skin of hard chromium reproduces exactly the form and surface variation of the part and that in the case of highly polished items there is no loss in micro finish. The base materials can be plain or alloy steels, cast iron, or copper based alloys, but not aluminium or materials of the cemented carbide type.

The unit is 5 ft long. It consists of a plating bath and a washing tank with the associated control gear. A low voltage direct current supply is needed as the maximum working potential is 25 V. The ammeter is scaled for two current ranges from 0 to 15 and from 0 to 30A so that exact control can be maintained. A timing unit, adjustable up to 1 hour, controls the process.



The temperature of the vat is maintained at a constant level by a heater in the bath under the control of a thermostat, which can be seen mounted above the vat. An exhaust system of large capacity is provided with a fan controlled from the panel. The system can be varied to suit individual requirements. Indicator lights on the panel show when the plating is in process and also when it is finished; alternatively (or simultaneously) an audible warning can be included. The makers state that skilled platers are not required to operate the plant. *Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2.*

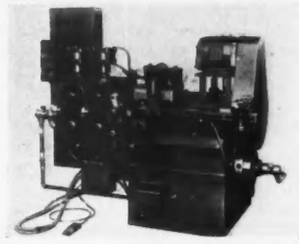
CUT-OFF MACHINE
Up to 2⅜ in Bar

AUTOMATIC bar cut-off machines made by Peltzer and Ehlers are now available in this country. The capacities range from 1 in to 2⅜ in diameter in 32 ton material.

The machines are primarily designed for cutting off blanks for the hot forming of bolts, and produce consistently accurate lengths with square end-faces. The output varies up to about 75 pieces per minute depending on the length. Lengths are infinitely variable up to 36 in in the largest machine. The minimum length should not be less than the diameter of the material. Round, square, or hexagon bar can be cut.

On the smallest machine, coiled material up to a wire diameter of ½ in can be sheared if required and for this a removable straightener is added.

Cut-off and feed mechanisms are controlled by a compressed air operated clutch and brake. Compressed air operated feed rollers grip the material, the action being synchronised to the



cycle. These rollers are adjustable and can be supplied with various profiles to suit the material being handled. Alternatively V grooved rollers can be used so that one or two sets can cover the whole capacity of the machine. Rollers with plastics surfaces can also be supplied.

It is possible for two bars to be fed simultaneously as the upper rollers are fitted with a compensating device to take up variations in limits. An electrical stop sets the bar to the correct length and contact with this stop initiates the shearing action. Completion of the cut starts the next cycle. *Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2.*

MOBILE HANDLING PLANT
Granular Material

A MOBILE pneumatic handling plant has been designed that will move up to 50 tons of wheat, or similar granular material, per hour.

The material can be drawn from a depth of 50 ft using an intake pipe up to 100 ft long. One bend can be included. The discharge pipe can also be 100 ft long but must be laid horizontally with no more than one bend. With more complicated systems the handling rate is reduced.

Power can be supplied by either a Paxman high speed diesel engine or by an electric motor where a mains supply is normally available. The air exhauster is of the Root's type with twin impellers coupled together by gearing. It is driven from the prime mover by V ropes which take up any distortion that may result from the machine standing on uneven ground.

The discharger section provides the air seal needed to maintain the partial vacuum within the system while allowing the material to pass through to the

blowing side of the plant. It is fitted with separate inlets for the main material stream from the receiver and for dust from the internal cyclone. The drive is through a slipping clutch that will operate a warning system if a foreign body becomes jammed between the rotor and the casing.

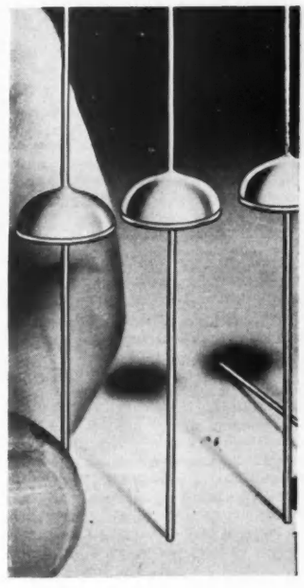
The receiver is mounted on its side to give the required volume while keeping the height down. The inlet is at the highest point and the material enters tangentially to separate the larger particles of dust. The remaining dust is separated in a built-in cyclone. *Spencer (Melksham) Limited, Melksham, Wiltshire.*

SILICON DIODES
High Temperature Operation

A RANGE of low cost silicon diodes capable of working at high temperatures is now available in this country.

They have been specifically designed for use in radio or commercial equipment that is required to operate at up to 70° C ambient temperature (equivalent to 100° C case temperature) with resistive, inductive or capacitive loads. They will provide full power under normal convection cooling.

Two sizes are made. The 5E4 is rated for a peak inverse voltage of 400 and a maximum RMS input voltage of 140 V (capacitive) or 280 V (resistive). The corresponding d.c. outputs are 350 and 500 mA at 70° C. The maximum surge current is 5,000 mA. Direct current voltage drop at full load is 1·3 V. The second size, the 2E4, is rated for an output of 200 mA (capacitive) or 300 mA (resistive) and the surge current is 2,000 mA. Both are multisealed and are said to be resistant to shock. *International Rectifier Company (Great Britain) Limited, Hurst Green, Oxted, Surrey.*



POWER UNIT

All Transistors

A TRANSISTORISED low voltage power supply unit is now on the market with a highly stabilised output.

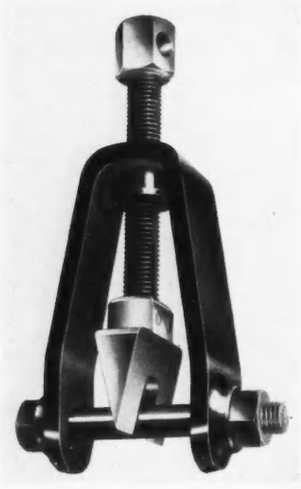
The output voltage is variable from 2·5 volts to 24 volts with an available current of from 1·25A to 0·2A. A power limiting switch restricts the output to a maximum of 12 watts, 2 watts or 500 mW to give protection to the external circuit. The shunt stabilisation allows the output terminals to be short circuited without causing any damage to the unit.

The d.c. supply is derived from a mains transformer via a full wave rectifier comprising two germanium junction diodes, and is fed to the output terminals via a series resistor. A high power transistor across the output forms a shunt regulator under the control of a transistor amplifier. The amplifier controlling the power transistor utilises a conventional circuit with four d.c. coupled transistors. The voltage appearing across the output terminals is applied to the base of the first transistor via a potentiometer, which controls output.

The load regulation of the unit is better than 0·01 volt and the ripple content is less than 0·5 V. The unit may be operated up to 45° C ambient. The output circuit is isolated from both the supply and the chassis so either terminal can be connected to earth. Alternatively the supply can float at up to 100 V above earth so that units can be connected in series. *Marconi Instruments Limited, St. Albans, Herts.*

FLANGE SPREADER

For Breaking Joints



THE flange spreader illustrated has been designed for breaking joints in pipelines.

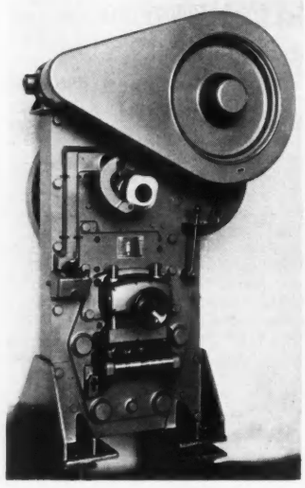
Claims are that it will open joints quickly and safely avoiding the use of wedges, chisels and hammers. Damage to the face of the joint is kept to a minimum as the leverage exerted is under full control. There is no danger of fire or explosion due to the generation of sparks. In addition, the flanges can be held apart at a required distance to enable the joint to be cleaned and prepared for resealing.

In operation all bolts are first removed from the flanges and the pin of the spreader inserted in place of one of them. For large pipes two spreaders can be used diametrically opposite. The screw is then tightened to force the wedge between the flanges until the joint is caused to open.

The spreader is made from mild steel with a nickel-chrome steel screw. The wedges are tool steel, hardened and tempered. Various sizes are made to suit all pipe sizes, and blunt wedges for ring joint flanges are available. *Borer Engineering Company, 54 Park Lane, Croydon, Surrey.*

BILLET SHEARS

Capacity up to 8 $\frac{21}{32}$ in



THE range of billet shears made by Valdarno of Italy is now available in this country.

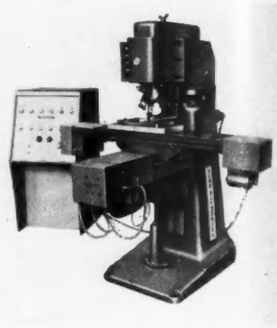
The machines have been made for speedy operation, cutting round and square bars using the standard blades, and flat plate using special blades. There are nine sizes covering bars from 1 $\frac{1}{32}$ in diameter to 8 $\frac{21}{32}$ in diameter.

A three-phase electric motor with star-delta starter provides the drive through a V belt to the flywheel. The latter is secured to a pinion that drives the train to the shears. A rolling key clutch is fitted on the camshaft gear to enable the machine to operate either continuously or as a single cycle.

A friction disc is fitted at each side of the flywheel to act as a clutch and prevent damage due to overload. No shear pin is fitted. The driving pinion is in the centre of the frame to avoid undue stresses and the flywheel is close to the side of the frame to avoid overhang. To ensure a true cut of the blades, the holder for the movable blade is adjustable. Lubrication is by hand pump feeding all main parts. *Sharston Engineering Company Limited, Wythenshawe, Manchester 22.*

TURRET DRILL

Tape Control



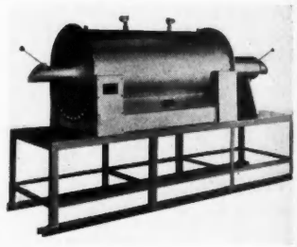
A TURRET head drill with tape control, now on the market, is said to be the first capable of drilling 660 holes in 6 sizes without human intervention.

The control system of the Vero autodrill is made by Airmec and operates by measuring the angular rotation of the lead screws, using a positioner unit consisting of a series of commutator type switches. Manual operation, if required, is performed from a control panel, and automatic drilling is controlled by a plastics tape carrying information for up to 600 complete drilling or tapping operations. The main feature of the system is that it is electrical rather than electronic.

The machine is fitted with a coordinate table measuring 32 in by 9 in and having a longitudinal travel of 24 in and a cross-traverse of 12 in. The positioning speed is 60 in per minute and an overall accuracy of $\pm$ 0·003 in is guaranteed. The turret head is fitted with six chucks for accommodating drills of up to $\frac{1}{16}$ in diameter and spindle speeds from 300 to 6,000 r.p.m. are provided. The maximum distance from the table to the spindle is 18 in. The tape information controls the position of the table; the selection of the head on the turret; and the selection of the drilling speed. It is particularly claimed that the large range of drill sizes and speeds make the machine suitable for most light work. *Catmur Machine Tool Corporation Limited, 103 Lancaster Road, Ladbroke Grove, London, W11.*

SINTERING FURNACE

Up to 1,650° C



A HEAVY duty sintering furnace for operation at temperatures up to 1,650° C using an atmosphere of hydrogen is now on the market.

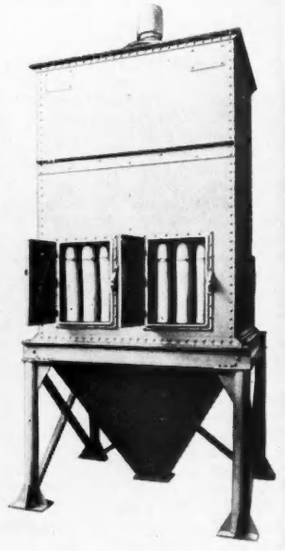
The heating chamber is a replaceable tube of fused alumina 5 in inside diameter and 32 in heated length. Fused alumina tiles, housing the molybdenum heating elements, surround the tube along the heated length and also support the tube allowing free dissipation of heat and providing mechanical strength. High temperature insulation of porous alumina behind the bricks is backed by graded thermal insulation reducing losses to a minimum. A mechanical failure of the tube does not cause failure of the elements.

An atmosphere of hydrogen or cracked ammonia is fed through an inlet under the furnace to distribution pipes in the thermal insulation in the base. The gas percolates through the insulation absorbing heat and is therefore preheated before entering the work tube. Auxiliary inlets allow an increase in gas flow when the doors are open. A burn-off at both doors consumes excess hydrogen and prevents ingress of oxygen.

Heating is divided into two independent automatically controlled zones along the length of the chamber. Automatic temperature control, mounted on a separate desk, comprises three-position indicating type controllers operating motorised voltage regulators giving stepless variation of the low voltage element supply. As the current is never switched off, very smooth control is obtained. The furnace is rated for 25 kW and is arranged for operation on a three phase supply. *Royce Electric Furnaces Limited, Sir Richards Bridge, Walton-on-Thames, Surrey.*

DUST FILTER

Automatic Cleaner



NOW being made in this country is the Fischer automatic dust filter. There are two basic types, one with 24 rectangular pockets and the other with 27 circular filter sleeves.

Dust-laden air enters near the bottom and most of larger particles are deposited in the collection hopper. The remainder of the dust is trapped in the fabric filter pockets while the clean air passes on to the outlet at the top and so to the extractor fan. The filter chamber is under vacuum the whole time.

Two or more filters are installed in parallel to allow for one being cleaned at a time. At set intervals, depending on the concentration of dust, a motor-operated damper in one of the filters bypasses the dusty air and opens a purging air connection. The filter chamber remains under suction. The purging air passes through the pockets in the reverse direction and the dust falls into the hopper. At the same time the pockets are vibrated. *Keith Blackman Limited, Mill Mead Road, London, N17.*

ENGINEERING CONTRACTS

Policy at the Ministry of Works in relation to the placing of Government contracts for building and civil-engineering works was reviewed in the House of Commons last week. A number of points were raised by Mr. Leslie Spriggs (Labour). In particular, he asked to what extent all such contracts were subject to open competitive tendering and the acceptance of the lowest price offered. He also inquired about the proportion of contracts which had been placed without competitive tendering from 1955 onwards.

Lord John Hope, the Minister of Works, emphasised that it was his department's policy to place contracts for such works at a fixed price with the lowest bidder after competitive tendering by approved contractors. Only in the most exceptional circumstances were contracts placed without competition or to anyone but the lowest tenderer. The number of contracts placed from the beginning of 1955 to date was 40,486. To give a figure for the exceptional cases where the contract had been placed without competition, or where the lowest tenderer had been passed over, would make heavy calls on staff time in examining all the 40,000 files.

The proportion of exceptional cases, however, was almost certainly less than 1 per cent.

PROGRESS ON NEW FORTH BRIDGE

Concern about the rate of progress being made in connection with the new Forth road bridge was expressed by Mr. J. A. Stodart (Conservative) and Mr. Harry Gourlay (Labour). They both questioned the Joint Under-Secretary of State for Scotland regarding a suggestion that the bridge might not be completed until the autumn of 1964, a year behind the scheduled date.

On this matter, Mr. Niall Macpherson said that his chief, the Secretary for Scotland, was quite satisfied with the progress of the work. The contract for the main structure was due to be completed at the end of 1963 and he had no reason to believe that that date would not be met. The contracts for the approach roads and viaducts had still to be placed but they would be phased to meet the date mentioned.

Work on the first contract for the piers, foundations and anchorages was up to date. The side tower on the north was virtually complete and work had started on the side tower on the south, for which the same erection plant was being used. Work on the construction of the foundations for the two main towers of the bridge was proceeding satistactorily. Excavation for the anchorage tunnels on both sides was virtually complete and the assembly of the internal steel work in the south tunnel was in hand.

Under the second contract, which was for the superstructure of the bridge, most of the steel for the main towers had been ordered and the shop fabrication of the steel had started. Work under contract No. 2 was likely to commence on the site early next year.

TAY ROAD BRIDGE AT DUNDEE

A statement was sought by Mr. G. M. Thomson (Labour) regarding the progress being made with the preparatory work connected with the building of a new road bridge across the River Tay at Dundee. He regarded the matter as one of urgency and pressed the Government to give every support to the tabling of a Provisional Order in March for the construction of this bridge and felt that the Order should then proceed through Parliament as quickly as possible.

Mr. Niall Macpherson replied that the local authorities concerned had been holding discussions with interests which would be affected by the erection of a bridge at Dundee and had been carrying out certain preliminary technical investigations. The Secretary for Scotland expected to receive a full report on the progress of these investigations at a meeting with the representatives of these authorities which had been arranged to take place on 11 December. It was the Government's intention that a start should be made on this bridge within the next five years, provided that the local authorities concerned sought and obtained the necessary powers.

He explained that the promotion of a Provisional Order was the first stage in obtaining the required authority for the bridge. Plans had to be deposited at the same time as a Provisional Order and there was a good deal of engineering work to be done before the necessary plans could be prepared. A start " within five years " did not mean that five years would elapse before a beginning was made.

NOISE IN BUILDING WORK

Attention was drawn by Mr. R. Gresham Cooke (Conservative) to the large amount of structural building work now proceeding in London and other large cities and to the noise made by the pneumatic drills and piledrivers used in this work. He asked the Minister of Education to state what work had been, or was being, carried out by the Building Research Station to reduce this problem and if the Minister would request the Station to accelerate its researches into the problem with a view to reducing the nuisance at an early date. He was told by Sir David Eccles that no such work was being undertaken at the Station. Individual problems of industrial noise were the subject of research at the National Physical Laboratory and the Government were considering what further measures could be taken to deal with the problem.

ENGINEERING RESEARCH GRANTS

Contributions by the Department of Scientific and Industrial Research to the Production Engineering Research Association were the subject of a question put by Mr. Austen Albu (Labour) to the Minister of Education. Sir David Eccles told him that the annual grant last year amounted to £89,850 and would be on the same terms this year, that is, a block grant of £65,000 provided that £100,000 was raised from industry, together with an additional grant of £50 for every £100 of industrial income up to a maximum additional grant of £25,000.

In addition, contributions would also be made this year, under a maximum offer of £15,000 towards £30,000 required for a three-year scheme for making the results of research better known and for encouraging their application; and, under a maximum offer of £100,000, towards the capital cost of a new building for the demonstration of new production techniques augmenting the advisory services. The actual amounts to be given under these offers would depend upon the support received from industry.

MACHINE TOOL IMPORTS

The President of the Board of Trade was asked by Mr. Peter Tapsell (Conservative) about the application of the Machine Tool Trades' Association for the discontinuance of the arrangements for the remission of import duty on individual importations of machine tools, together with a reduction of the duty on these products. Mr. Reginald Maudling replied that careful consideration had been given to the application and to the views of other interested parties. As a result of this consideration, he had decided that it would be in the national interest to accept the proposal.

Accordingly, the Import Duties (General) No. 10 Order had been introduced. It came into operation on 25 November and reduced the duties on machine tools covered by tariff heading 84.45 (B) from 17½ per cent to 10 per cent *ad valorem*. No further applications would be accepted for the remission of duty, under section 6 of the Import Duties Act, 1958, on machine tools covered by this tariff heading unless they had already been ordered. The arrangements for duty remission on parts for incorporation in machine tools being manufactured in this country, while being continued for the present, would cease at the end of 1960.

ROAD DEVELOPMENT PROGRAMMES

It was pointed out to the Minister of Transport by Mr. G. A. Pargiter (Labour) that Birmingham Corporation was seeking the approval of the Government for an expenditure of £37 million on major road works during the five-yearly period 1962 to 1966. The London County Council wished to start, during the period from 1960 to 1965, a programme of major works expected to cost £17 million.

In addition, there would be minor schemes, and Mr. Pargiter accordingly asked Mr. Ernest Marples to state the level of the Government grants which would be available to assist these schemes. He was informed that these proposals had only very recently been put before the Ministry's divisional road engineers. It was too early to say what the outcome would be.

Motor Manufacture in Scotland

Mr. William Hamilton (Labour) wanted the President of the Board of Trade to state what steps he was taking to encourage motor-car manufacturers to establish an industry in Scotland. In reply, Mr. Reginald Maudling said that he intended to do all he could to induce manufacturers in the motor-vehicle and component industries to establish new capacity in the unemployment areas in Scotland and elsewhere.

Moving to Wales

Information was sought by Mr. George Thomas (Labour) regarding the movement of new industries to Wales. He was informed by Mr. John Rodgers, Parliamentary Secretary to the Board of Trade, that precise information was not available, but that 181 British firms operating in the London and South Eastern and Midland regions were known to have opened branches in Wales since 1945. Of that number, 66 were no longer operating there. These, however, were mainly firms providing little employment.

Employment in Iron Founding

There has been a significant reduction in unemployment in the iron-founding industry in Scotland during the present year, according to information supplied by Mr. Edward Heath, the Minister of Labour. He informed Mr. Malcolm MacPherson (Labour) that between mid-January and mid-October, unemployment in iron founding in Scotland had declined from 1,006 persons to 779 persons. The figures for mid-October were the latest at present available.

Improvements to Hull Docks

A scheme for improvements at King George Dock, Hull, has recently been authorised by the British Transport Commission. According to information given by Mr. Ernest Marples, the Minister of Transport, to Commander Harry Pursey (Labour), the scheme is expected to cost about £4¾ million. The improvements envisaged include the extension of three quays and the provision of additional transit sheds, cranes, grain elevators and silo accommodation. On the employment aspect, the direct effect of the project would be limited this winter to design staffs.

Sulphur Removal Process

Details of the means by which an avoidance of air pollution has been brought about by collaboration between the Central Electricity Generating Board and the Department of Scientific and Industrial Research, especially at the North Wilford Power Station, were sought by Mr. Ellis Smith (Labour) from the Minister of Housing and Local Government. In his reply, Sir Keith Joseph, the Ministry's Parliamentary Secretary, said that these two bodies collaborated in the measurement of air pollution and, in conjunction with Simon Carves Limited, had been conducting an experiment into a sulphur-removal process, on a pilot plant scale, at North Wilford Power Station. The results of that experiment were being awaited with interest.

XUM

MEETINGS AND PAPERS

British Institution of Radio Engineers

LONDON
"Magnetic Recording Techniques." Half-day symposium, comprising eight papers. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Tues., 15 Dec., 3 p.m. and 6 p.m.*
"Measurements in the Presence of Noise," by Dr. D. A. Bell and Dr. G. D. Dawson. Medical Electronics Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 16 Dec., 6.30 p.m.*
BRISTOL
"Transistor and Its Use in Communication and Control Equipment," by E. Wolfendale. South Western Section. School of Management Studies, Unity Street, Bristol. Thurs., 17 Dec., 7 p.m.
EDINBURGH
"Digital Voltmeter," by J. A. Irvine and D. A. Pucknell. Scottish Section. Department of Natural Philosophy, The University, Drummond Street, Edinburgh. Fri., 18 Dec., 7 p.m.
GLASGOW
"Digital Voltmeter," by J. A. Irvine and D. A. Pucknell. Scottish Section. 39 Elmbank Crescent, Glasgow, C2. Thurs., 17 Dec., 7 p.m.

Combustion Engineering Association

MANCHESTER
"Heat Insulation," by Martin Edge and R. A. Mansergh. North Western Region. Engineers' Club, Albert Square, Manchester. Tues., 15 Dec., 2.30 p.m.

Diesel Engineers and Users Association

LONDON
"Report on Heavy Oil Engine Working Costs and Performance, 1958-59"; and "Operating Problems": Discussion. Also "Inventions of the British Internal Combustion Engine Research Association," by Dr. W. P. Mansfield. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 17 Dec., 2.30 p.m.

Illuminating Engineering Society

LIVERPOOL
"New Development in the Calculation of Coefficients of Utilisation," by W. Robinson. Liverpool Centre. Industrial Development Centre, Merseyside and North Wales Electricity Board, Liverpool. Tues., 15 Dec., 6 p.m.
SHEFFIELD
Technical Films. Sheffield Centre. Grand Hotel, Sheffield. Mon., 14 Dec., 6.30 p.m.

Institute of Fuel

LONDON
"Practical Aspects of the Use of Liquid Petroleum Gases in Industry, Especially in Metallurgical and Ceramic Industries," by J. P. Liotier; "Controlled Atmospheres Produced with Liquefied Petroleum Gases," by J. S. Wilding and A. G. Turner; and "Present and Future Position of Liquid Petroleum Gases," by A. G. Turner, R. F. Horner and P. C. Jarvis. Institution of Civil Engineers, Great George Street, SW1. Wed., 16 Dec., 5.30 p.m.*
EDINBURGH
"Transport and Utilisation of Liquid Methane Gas." Discussion. Scottish Section. North British Hotel, Edinburgh. Tues., 15 Dec., 7 p.m.

Institute of Marine Engineers

LONDON
"Some Aspects of Marine Reactor Safety," by K. Maddocks. Joint Nuclear Marine Propulsion Panel. Tues., 15 Dec., 5.30 p.m.*
BRISTOL
Technical Films. West of England Section. University of Bristol, University Walk, Bristol 8. Mon., 14 Dec., 7.30 p.m.
KINGSTON-UPON-HULL
"Steam and Steam Generation," by J. Anderson. Kingston-upon-Hull and East Midlands Section. Royal Station Hotel, Kingston-upon-Hull. Wed., 16 Dec., 7.30 p.m.

Institute of Metal Finishing

BIRMINGHAM
"Polyurethane Finishes and Foams," by R. Hurd. Organic Finishing Group. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. Wed., 16 Dec., 6.30 p.m.

Institute of Petroleum

LONDON
Redwood Lecture, by A. C. Hartley. Wed., 16 Dec., 5.30 p.m.*

Institute of Physics

LONDON
"Tubes for Colour Television," by K. G. Freeman. Electronics Group. Tues., 15 Dec., 5.30 p.m.*
MANCHESTER
"Aesthetic Design of Scientific Instruments," by R. H. Litherland. Manchester Branch. The University, Manchester. Mon., 14 Dec., 7 p.m.

Institute of Road Transport Engineers

LONDON
"Selection, Specification and Design of a Commercial Vehicle," by E. B. H. Elsbury. Royal Society of Arts, John Adam Street, Adelphi, WC2. Thurs., 17 Dec., 6.30 p.m.
LEEDS
"Diesel Power Units," by D. Kaberry. Yorkshire Centre. Great Northern Hotel, Wellington Street, Leeds 1. Thurs., 17 Dec., 7.30 p.m.

Institution of British Agricultural Engineers

NEWCASTLE UPON TYNE
"Mechanical Handling and Preparation of Feeding Stuffs on the Farm," by John T. Taylor. Northern Centre. Offices of the North Eastern Electricity Board, Carliol House, Newcastle upon Tyne. Mon., 14 Dec., 6.45 p.m.
PERTH
"Accident Prevention on Farms," by J. Brownlie. Scottish Centre. Offices of the North of Scotland Hydro-Electric Board, Blackfriars, Perth. Mon., 14 Dec., 7.30 p.m.

Institution of Civil Engineers and Société des Ingénieurs Civils de France (British Section)

LONDON
"New Dam Techniques," by André Coyne. Tues., 15 Dec., 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Why Hi-Fi?" Discussion opened by P. P. Eckersley. Mon., 14 Dec., 5.30 p.m.*
"Data Handling Problems in Atomic Installations." Discussion opened by Dr. D. Taylor. Measurement and Control Section. Tues., 15 Dec., 5.30 p.m.*
"Laying of Submarine Cables," by Captain W. H. Leech. Electronics and Communications Section. Wed., 16 Dec., 5.30 p.m.*
"Presentation of the History and Philosophy of Science." Discussion opened by Professor H. Dingle. Education Discussion Circle. Thurs., 17 Dec., 6 p.m.*
CARDIFF
"Provision of Adequate Electrical Installations in Buildings": (a) "Multi-Storey Flats and Maisonettes," by C. A. Belcher; and (b) "Small Industrial Premises," by J. A. Sharp. Western Centre. Reardon Smith Hall, Cardiff. Mon., 14 Dec., 6 p.m.*
CHESTER
"Generator-Motor Problems in Pumped Storage Installations," by Dr. J. H. Walker. Mersey and North Wales Centre. Town Hall, Chester. Mon., 14 Dec., 6.30 p.m.
EDINBURGH
"Provision of Adequate Electrical Installations in Buildings" (as above). South East Scotland Sub-centre. Carlton Hotel, Edinburgh. Tues., 15 Dec., 7 p.m.
FARNBOROUGH
"Subscriber Trunk Dialling," by D. A. Barron. Southern Centre. Technical College, Farnborough. Tues., 15 Dec., 6 p.m.
GLASGOW
"Provision of Adequate Electrical Installations in Buildings" (as above). South West Scotland Sub-centre. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Wed., 16 Dec., 6 p.m.

Institution of Engineering Designers

NEWCASTLE UPON TYNE
"Technical Aspects of Independent Television," by D. G. Packham. North East Branch. Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne. Mon., 14 Dec., 7.15 p.m.

Institution of Engineers-in-Charge

LONDON
"Gas Transmission in the United Kingdom," by D. L. Copp. Caxton Hall, off Victoria Street, SW1. Wed., 16 Dec., 6.30 p.m.*

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
"Refrigerated Ships," by E. Russell Roberts. Tues., 15 Dec., 6.30 p.m.*

Institution of Heating and Ventilating Engineers

GLASGOW
"Clean Air Act." Discussion. Scottish Branch. Scottish Building Centre, 425-427 Sauchiehall Street, Glasgow, C2. Tues., 15 Dec., 7 p.m.

Instutition of Locomotive Engineers

LONDON
"Methods of Reducing Flange Wear on Diesel and Electric Bogie Locomotives," by W. L. Topham. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Tues., 15 Dec., 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
"Future of Air-Breathing Engines in Aviation," by Dr. S. G. Hooker. James Clayton Lecture. Wed., 16 Dec., 6 p.m.*
Film Evening. London Graduates' Section. Tues., 22 Dec., 6.30 p.m.*
LEEDS
"Effect of Nuclear Radiation on Engineering Materials," by A. H. Cottrell. Thomas Hawksley Lecture. Yorkshire Branch. The University, Leeds. Thurs., 17 Dec., 6.30 p.m.
MAIDSTONE
"Effect of Nuclear Radiation on Engineering Materials," by A. H. Cottrell. Thomas Hawksley Lecture. Southern Branch. Royal Star Hotel, Maidstone. Wed., 16 Dec., 7.30 p.m.
NEWCASTLE UPON TYNE
"Energy Balance in Steam Power Plant Systems," by R. S. Silver. North Eastern Branch. Stephenson Building, Claremont Road, Newcastle upon Tyne. Thurs., 17 Dec., 6.15 p.m.

Institution of Mining and Metallurgy

LONDON
"Relationship Between Particle Size and Collector Concentration," by Dr. A. J. Robinson; and "Deepening of No. 1 Vertical Shaft at Premier (Transvaal) Diamond Mining Co., Ltd.," by D. Borchers. Geological Society, Burlington House, Piccadilly, W1. Thurs., 17 Dec., 5 p.m.*

Institution of Plant Engineers

BIRMINGHAM
Mobile Plant Discussion Group Meeting. Birmingham Branch. Imperial Hotel, Temple Street, Birmingham. Fri., 18 Dec., 7.30 p.m.
LEICESTER
"Fibre Glass in Industry," by R. Loughran. Leicester Branch. Bell Hotel, Leicester. Wed., 16 Dec., 7.30 p.m.

Institution of Production Engineers

GLASGOW
"Welding and Marine Engineering," by J. A. Drrat. Glasgow Section. 39 Elmbank Crescent, Glasgow, C2. Thurs., 17 Dec., 7.30 p.m.
LEEDS
"Materials Purchase as an Aid to Production," by D. H. Brandon. Leeds Section. Hotel Metropole, King Street, Leeds 1. Mon., 14 Dec., 7 p.m.
SHEFFIELD
"Fabrication of Heavy Steel Components," by W. Plews. Sheffield Section. Grand Hotel, Sheffield. Mon., 14 Dec., 7.15 p.m.

Institution of the Rubber Industry

BIRMINGHAM
"Ageing and Weathering of Rubber and Some Plastics," by Dr. W. McG. Morgan. Midland Section. James Watt Memorial Institute, Great Charles Street, Birmingham. Mon., 14 Dec., 6.45 p.m.

Institution of Structural Engineers

GLASGOW
"Goliath Crane at Hunterston Atomic Power Station," by A. Henderson. Scottish Branch. Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. Tues., 15 Dec., 7 p.m.

Junior Institution of Engineers

LONDON
"Radioisotopes in Industry," by W. G. Busbridge. Fri., 18 Dec., 7 p.m.*

Reinforced Concrete Association

BIRMINGHAM
"Design and Construction of the Shell Roof of the Exhibition Palace of the National Centre of Industries and Technology, Paris," by J. E. C. Farebrother and M. Nicholas Esquillan. Midland Counties Branch. Birmingham and Midland Institute, Paradise Street, Birmingham. Tues., 15 Dec., 6 p.m.

Royal Aeronautical Society

LONDON
Astronautics and Guided Flight Section Meeting. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Thurs., 17 Dec., 6 p.m.*

Royal Meteorological Society

LONDON
"Seasonal and Other Temperature Changes in the Antarctic Atmosphere," by Dr. H. Wexler. Wed., 16 Dec., 5 p.m.*

Royal Statistical Society

LONDON
"Statistics as a Tool of Management," by Sir Hugh Beaver. Presidential Address. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 16 Dec., 5.15 p.m.*

Sheffield Metallurgical Association

SHEFFIELD
"Developments in Heavy Plate Steels," by W. Barr. BISRA Laboratories, Hoyle Street, Sheffield. Tues., 15 Dec., 7 p.m.

Society of Chemical Industry

LONDON
Research Problems Discussion. Wed., 16 Dec., 6 p.m.

Society of Instrument Technology

LONDON
"Random Inputs and Load Variations," by J. F. Coales. 26 Portland Place, W1. Wed., 16 Dec., 7 p.m.*
CHESTER
"Cost Control in Instrument Engineering," by S. Sheridan and J. Reed. English Speaking Union, Stanley Palace, Watergate Street, Chester. Thurs., 17 Dec., 7 p.m.
NEWCASTLE UPON TYNE
Open Discussion Meeting. Newcastle Section. Roadway House, Oxford Street, Newcastle upon Tyne. Wed., 16 Dec., 7 p.m.

West of Scotland Iron and Steel Institute

GLASGOW
"Self-Fluxing Sinter," by E. H. Baldwin, I. M. Mathieson and D. McNeil. Fri., 18 Dec., 6.45 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor at least three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Diesel Engineers and Users Association, 18 London Street, London, EC3. (ROYal 2393)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Metal Finishing. Apply to 11A Gloucester Road, London, SW7. (KNIghtsbridge 9181)
Institute of Petroleum, 61 New Cavendish Street, London, W1. (LANgham 3583)
Institute of Physics, 47 Belgrave Square, London, SW1. (BELgravia 6111)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institution of British Agricultural Engineers, 6 Buckingham Gate, London, SW1. (TATe Gallery 8589)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineering Designers, 38 Portland Place, London, W1. (LANgham 8847)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Locomotive Engineers, 28 Victoria Street, London, SW1. (ABBey 6672)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Mining and Metallurgy, 44 Portland Place, London, W1. (LANgham 3802)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W8. (BAYswater 9101)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, SW7. (KENsington 0730)
Royal Statistical Society, 21 Bentinck Street, London, W1. (WELbeck 7638)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Société des Ingénieurs Civils de France (British Section), 82 Victoria Street, London, SW1. (VICtoria 6838)
Society of Chemical Industry, 14 Belgrave Square, London, SW1. (BELgravia 3681)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
West of Scotland Iron and Steel Institute, 39 Elmbank Crescent, Glasgow, C2. (Central 5181)

Heating Without Fires

The effect of air conditions upon paraffin heaters is to be examined by the Department of Scientific and Industrial Research. This was made known by the Coroner, Mr. E. A. Williams, conducting the inquest upon the tragic deaths by fire of five Hertfordshire children in whose council house home fire broke out when their father went out leaving the door open while a paraffin burning stove was alight in a downstairs room.

The coroner's jury added a rider to their verdict of accidental death suggesting that makers of paraffin heaters should take measures to remove dangers and warn the public to observe their instructions exactly.

That there were millions of similar heaters to the one in use in this case was pointed out by the Coroner, who acknowledged that there was a lot to be said for the case put forward by the manufacturers.

Mr. Dennis Lawson of the DSIR said that their attention had recently turned to the number of fires in which paraffin heaters were given as the probable cause because their number appeared to be increasing faster than the domestic consumption of paraffin, indicating an increasing danger. The number of fires thought to have been caused by paraffin heaters rose from 300 in 1950 to 1,300 in 1957.

In the field of electrical appliances agreement has been reached after long discussions on the setting up of an organisation for the approval of domestic electrical appliances and for keeping and publishing a list of approved appliances. Agreement was reached at a meeting of the British Electrical and Allied Manufacturers' Association, representatives of the electrical supply industry, the British Standards Institution, and from the electrical contractors, wholesalers and retailers. A provisional board of management was formed with Mr. T. E. Daniel, chairman of the North-West Electricity Board, and of the British Electrical Development Association as chairman.

The board will encourage the public to buy only those electrical appliances which bear its "Approved" mark. The approval mark will be based on a British Standard and will be open to all domestic electrical appliances made in or imported into Britain. Plans for its operation are already well advanced.

Training at Bristol Siddeley's

Prior to the full-scale manufacture of the Bristol Siddeley Orpheus turbojet engine in India next year, 70 employees of Hindustan Aircraft, Bangalore, have been training at the company's Bristol factories and in visits to other parts of Britain.

Most of these Indian technicians are of supervisor grade and they have been living at small hotels around Bristol, joining in the sporting and other activities of the company's staff and on occasion playing for Bristol sports clubs.

The agreement for the manufacture of the Orpheus under licence in India was signed in 1956 between the Indian Government and Bristol Siddeley at the same time as a similar agreement for the manufacture under licence of the Orpheus powered Folland Gnat light fighter.

The training programme is outlined by Hindustan Aircraft and the details worked out by Bristol Siddeley. The average length of stay in this country has been between four and six months and most of the work has been done in the production factory on a variety of aspects of machining, welding, engine build, testing and production planning and control.

Not all of the time has been spent at Bristol. Work has been done at the Whitchurch and Sunderland factories of the company, with sub-contractors in other parts of the country, and visits have been paid to the works of machine-tool makers in Germany and Switzerland.

The return of the last of the trainees in March or April next year will not break the personal link between the companies in England and in India. Already 19 Bristol Siddeley technicians and their families have gone to Bangalore, for about three years, to help with setting up the Orpheus engine factory and overhaul base. Visits to Bangalore by Bristol Siddeley engineers and return visits from Hindustan Aircraft personnel will continue from time to time.

Think Before You Buy

The Trades Union Congress wants the Government to give stronger legal protection to consumers. As the supermarket and prepackaging reduce the shopper's chance to tell for himself what he is getting and remove the candid shop assistant from his elbow there is an increasing need, in the TUC's view, for giving the customer more information, on contents and qualities and handling requirements.

There is also a need to tighten up the Merchandise Marks Acts and their enforcement. These Acts are supposed to stop false and exaggerated claims, but the TUC, in its recent evidence to the Committee on Consumer Protection, pointed out that only 94 prosecutions have been made in the last nine years.

Operating in the field of consumer protection already are two bodies: Consumers Advisory Council of the British Standards Institution and Consumers Association Limited, which has grown rapidly both in members and the range of its tests since its inception. The CAC suffers the disadvantage of not being independent of the BSI, a freedom the desirability of which it has itself urged. The Consumers Association still has the size of a David against the Goliath's whose first interest is not always that of informing the housewife.

What the TUC would like to see is an independent body, assisted out of public funds, acting as the national council for the protection of the shopping public. Along with powers to test and report publicly on consumer goods of all types, to advise people and organisations representing consumers, and to fully publicise all this, the TUC would like to see this body encouraging both BBC and commercial television to carry regular programmes on consumers' problems at peak times. This conjures up the prospect of commercial television following up the hopeful, dream fulfilling ad-spells with periods given over to the cool, clear tones of reason. What the commercial television monopolists would think of that requires no imagination at all.

American in Old England

The manner in which the pioneers of United States industry came here to learn the techniques of manufacture was the subject of this year's Newcomen lecture that was read at the Science Museum, London, by two Americans, Dr. Harold B. Hancock and Dr. Norman B. Wilkinson. In the introduction to their subject: "Joshua Gilpin: An American Manufacturer in England and Wales, 1795-1801," they emphasise the protective British outlook of the time. In the period 1790 to 1920, "England tried to maintain her industrial leadership by prohibiting the emigration of artisans and mechanics and the export of machinery and machine drawings." But little stood in the way of an enterprising American "with ample time, funds and introductions" who wished to visit the manufacturing centres where the new methods and machines, were turning out the products in which he was interested.

Joshua Gilpin, who founded the first paper mill in the State of Delaware in 1787, spent seven years observing and noting the methods of the paper industry in Britain and a great deal else, including potteries, coal mining, iron manufacture and that of other metals. The things which interested Joshua Gilpin and which he described so well in his journal provide also a valuable insight into the psychology of industrial process.

Thoughtful Watch

Parking meters are international; the French have their disc system, it took the Swiss to devise the parking watch.

The Swiss wrist watch is highly skilled. As any other alarm it starts the day by waking its owner —no hope of it failing there from not being wound—if the watch is wound at all the alarm gets wound with the movement. Coming to the parking duties, cars sometimes are left on the right hand on some days, on the left the others. So this watch has a system of red figures for even days and black for odd.

A black day indeed for the motorist who hurries out with his wrist buzzing away only to be faced with telling the waiting policeman—"my watch is slow."

Share Gifts Tax

The recent gift by Imperial Chemical Industries of £2·34 million worth of ordinary shares to their employees was one each employee received "by virtue of his employment" and therefore within the scope of schedule E taxation. In this case, however, the figure was net, as tax had already been deducted (PAYE at the appropriate rate) by the trustees of ICI's shares-for-employees scheme.

The law is that all remuneration—salaries, fees, wages, perquisites and profits whatsoever—arising from employment is subject to tax. Personal gifts are exempt but it has to be established that they have been made in circumstances unconnected with the employment of the persons who receive them. In ICI's case this is clearly not so, since the cash used to purchase shares for employees is paid out from company profits, in the same way that dividends and interest are paid out on share and loan capital. In fact, the total amount of funds paid into the shares-for-employees scheme this year was 22 per cent of such earnings.

The mechanics of the scheme are very simple: The total sum is paid to the nine trustees who hold it upon the trusts declared by a trust deed. It is then shared out among the employees qualified to participate in the scheme according to their individual rates of pay. Income tax is deducted under PAYE from the gross amount and the net amount used by the trustees to subscribe for ordinary stock at the current market price. When 40 £1 stock units have been thus accumulated for any particular employee, they are transferred to him by the trustees and he is free to do as he wishes with them.

New Design Chairman

Mr. Duncan M. Oppenheim, the chairman of the British-American Tobacco Company, is to succeed Sir Walter Worboys as chairman of the Council of Industrial Design.

The Council will be 16 years old next year, having been set up by the Board of Trade in the closing stages of the Second World War to promote the improvement of design in British industry. Sir Walter Worboys became a member of the Council in 1947 and has been its chairman for the past seven years.

The director of the Council, Sir Gordon Russell, is to retire at the end of the month and Mr. Paul Reilly, the deputy director, will step up one.

Half-Term Report Card

MEETINGS of the American Nuclear Society (ANS) show signs of becoming Geneva conferences for the interim period. Spaced at half-yearly intervals, the meetings provide an opportunity to present accumulated material which otherwise might have to wait for the next gathering at Geneva. The 1959 Winter Meeting of ANS was held in Washington, DC, from 4 to 6 November, and was attended by some 600 members and 400 visitors. Our special correspondent reports from Washington.

Economic Studies

Proceedings of this Winter Meeting were divided roughly into four main series, dealing with (*a*) reactor projects, designs and equipment; (*b*) metallurgy, reactor materials, chemistry and fuel elements; (*c*) experimental physics and nuclear properties; (*d*) mathematical theories and techniques for reactor analysis. There were in all 22 separate sessions in the three days. Comparison of reactor design studies for power plants in the 300 MW(e) category were sponsored by the USAEC.

Although not directly comparable because of slight variations in the ground-rules for the designs the schemes were sufficiently close to permit reasonably valid comparisons.

Pressurised Water Still the Cheapest in America

Nine reactor types have been studied in the power reactor programme of the USAEC during its five years of existence. Results of the study confirm that the enriched-fuel light-water systems offer the lowest generating costs today and are likely to remain the most economical in the future. The comparison was made on the basis of a single reactor 300 MW(e) plant, to be constructed only with proven techniques available in America today. As far more is known in America about the water reactors than any other types, this tends to put the gas-cooled and heavy-water moderated reactors at a disadvantage. From the American point of view it is acceptable to favour reactors developed in that country, as the decision to construct another type would involve greater costs. The generating cost distribution would change somewhat if all reactor systems were developed to the same degree, taking into account the potentialities of each system and assuming that the potentialities are fully realised. The bar diagram of Fig. 1 shows a comparison of generating costs from stations which can be built today, and also the costs from fully developed plants. The diagram also shows the anticipated development costs incurred by a decision to construct a 300 MW(e) reactor station. The largest power reactors built in America to date are the light-water reactors Shippingport and Dresden, both with 180 MW(e) output; it is estimated that $20 to $40 million would be required to scale up the power output to 300 MW(e). In contrast, the USAEC would expect to spend $130 million to develop a gas-cooled reactor, and $255 million for a heavy-water reactor of the same size, although similar reactors are already under construction in other countries. It appears that the USAEC do not expect to benefit much from the numerous agreements in existence on the exchange of information between Britain, Canada and the United States.

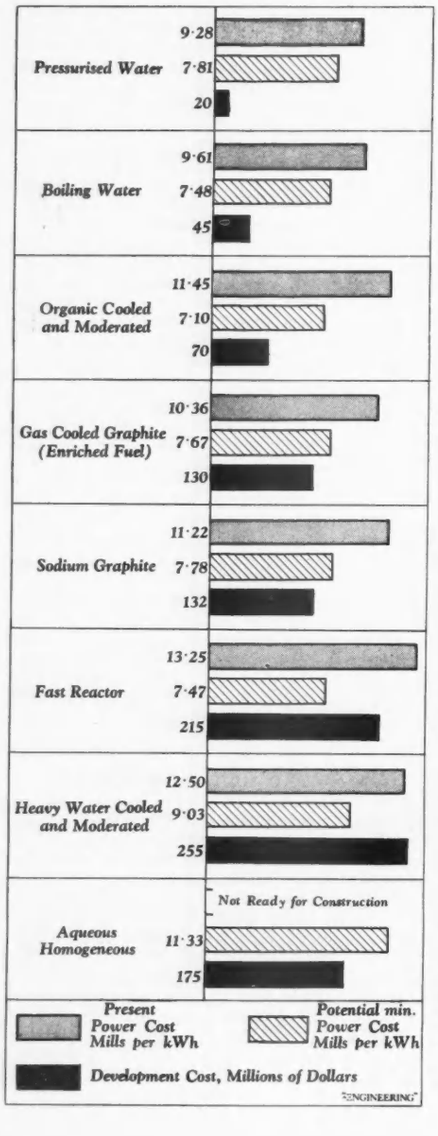


Fig. 1 (left) Generating costs of nuclear stations as built with present techniques and fully developed.

Fig. 2 (right) Advanced pressurised water reactor core with bulk boiling for 1,000 MW(t) output.

Comparative Power Costs

In comparing these US power generation costs with British costs it must not be forgotten that not only are capital charges and labour costs very different in the two countries, giving high capital and operating charges in America, but also that the cost of enriched uranium of some $15 per gram must be considerably lower than the British price. This is in part directly due to the very low cost of coal-generated electric power used to drive the diffusion plants, and in part due to the use of very large production units in the United States. Therefore the economics of enriched reactors would not appear so favourable compared to natural uranium systems in this country.

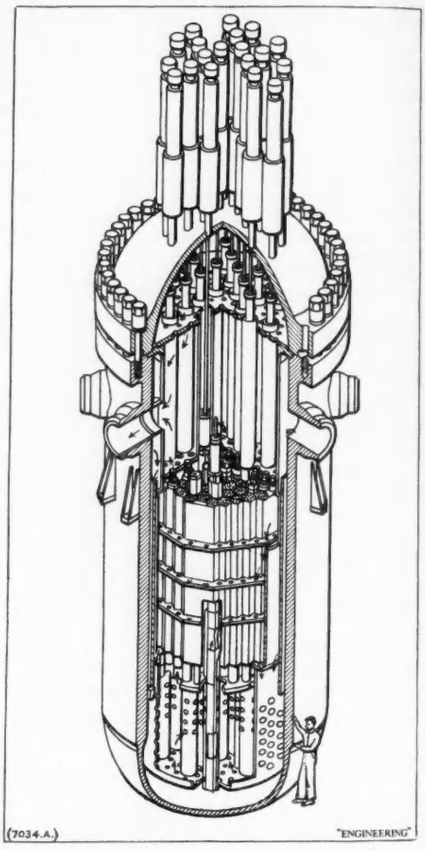
Advanced Pressurised Water Plant

The most fully developed design in the USAEC study was the PWR (pressurised water reactor), all features of which could be guaranteed for manufacture by the chosen date, although there were a few items upon which some degree of research and development would be essential. General features of this design, shown in Fig. 1, include: uranium dioxide fuel clad in stainless steel; two fuel zones, the inner enriched to 2·6 per cent uranium-235, the outer to 3·4 per cent, and both zones containing boron as a burnable poison; and an average burn-up of 1,300 MWD per tonne giving a charge life of 3½ years at 80 per cent load factor. Bulk boiling is allowed in the core, thereby enabling the high average primary coolant outlet temperature of 600° F (320° C) to be attained with the resultant high overall plant thermal efficiency of 34·5 per cent. A new type of " neutron rectifier " control rod coupled to a movable fuel element " tail " is used. It is only by employing this type of control rod that the required degree of control over so long a core life can be attained without the use of soluble poisons in the coolant. Essentially, a hexagonal fuel space is left free from fuel but full of water. The control absorber surface, in the form of a hexagonal tube of silver-cadmium-indium alloy, encloses this water so that epithermal neutrons leaking into the volume through the thermal-neutron absorbing control surface are thermalised in the water volume and are then captured by the control surface before they can leak back into the core. Thus the control rods operate upon both thermal and epithermal neutrons and are each effective over a larger volume of core than had they operated upon thermal neutrons only, since epithermal neutrons travel greater distances before they are absorbed in fuel or other materials. This is an important asset in an under-moderated reactor such as the PWR with its strong epithermal neutron spectrum component.

The designers claim that the combined savings in fuel fabrication (consequent upon the two-zone system), in control gear complexity (consequent upon the composite neutron rectifier fuel element), in the vapour container (consequent upon minimising the volume of the primary circuit), and in thermal efficiency (consequent upon the high outlet temperature permitted under bulk boiling conditions) bring the cost of power generated by this plant to be nearly competitive with coal burning plant. A coal burning plant built to the same ground-rules would produce power at about 7·1 mills per kWh, whereas it is claimed that this plant would generate power for 8·26 mills per kWh for one plant only, or 7·0 mills per kWh for four identical plants.

Boiling Water and Organic Cooled Systems

At the present time the two runners-up to the PWR are the BWR and the OCR, and it was seen at the Winter Meeting that the USAEC consider these two systems the likely winners in cheap power production. Papers presented to the meeting described a 300 MW(e) scheme of each type which were claimed ready for early construction. The BWR described



by L. F. C. Reichle of Ebasco Services and W. A. Hartman of General Electric was not carried to the degree of detail attained in the PWR design, but simply an improved version of the Dresden reactor with higher power density, power output and fuel irradiation. This reactor again depends upon uranium oxide fuel technology, but in this case Zircalloy clad compared with the stainless steel used in the PWR. The PWR is undermoderated as compared with the BWR (water to fuel volume of 1·12 compared with 2·5), requiring a moderately low negative steam void coefficient. The resulting high ratio of epithermal to thermal flux in the PWR enables stainless steel cans to be employed economically.

The organic cooled reactor described by J. D. Plawcham of the Bechtel Corporation and R. F. Wilson of Atomics International has in common with any OCR design, fairly high outlet temperature, low working pressure, cheap container material, use of standard pumps and equipment, low coolant radioactivity and easy on-load refuelling in exchange for the concomitant difficulties and penalties of coolant distillation and make-up, some fuel element surface fouling, inferior heat transfer, coolant system trace-heating, and the need for washing fuel elements on removal from the reactor. The net result is a claimed power generation cost of 7·31 mills under the specified conditions compared with 8·0 mills for the BWR,

although this conclusion does not seem to be fully accepted by the USAEC.

Other Topics

Many other topics were dealt with at the meeting besides the four USAEC sponsored economic studies, one of which, the heavy water reactor, has not been reviewed here: one of its pre-requisites was the ability to operate on natural uranium and hence be suitable for export to countries wishing to remain independent of American diffusion plants. Several advanced reactor schemes, some about to become reactor experiments, were also described. One particularly interesting experiment in this class is the Turret reactor, designed to operate at 2,400° F (1,300° C) on helium gas coolant with graphite moderation and uranium impregnated unclad graphite fuel elements, so that the primary circuit is highly radioactive. It is noteworthy that a British-made gas bearing hermetically-sealed compressor will be used to operate this 3 to 30 MW(t) experimental reactor, building of which at Los Alamos is scheduled to begin next year.

Turret Reactor for 2,400° F

To heat helium at 500 lb per sq. in to a temperature of 2,400° F (1,315° C) is the purpose of the turret reactor, which will be built by the Los Alamos Scientific Laboratory in cooperation with the Sandia Corporation. Atomic Review reported on the turret concept on 3 October, 1958, and showed a schematic illustration of the reactor core. The Los Alamos experiment will have a power of 3 MW(t), and will be used to study the behaviour of high temperature unclad fuel elements; the cost and efficacy of coolant decontamination procedures; the problems of coolant circuit clogging by solid particles; and to demonstrate the various methods of fuel cycling. The proposed core will consist of a short six-foot diameter graphite cylinder with an axial hole of 1 ft diameter. The fuel channels are arranged as spokes of 13 wheels on top of one another, each containing 24 spokes. The high pressure coolant will circulate from the axial hole out through the radial "spokes" to the periphery of the cylinder. The fuel elements will be tubular, with 1 in and 0·5 in outside and inside diameter, and will be fabricated by simply dipping an ordinary graphite sleeve into a solution of enriched uranium nitrate. A graphite and carbon reflector surrounds the core inside a 12 ft diameter steel containment sphere. The core is mounted on a turntable and may be rotated to bring any row of fuel channels opposite the stationary charge machine. Replacement of fuel elements is performed by a ram which pushes a fresh element into the channel. Refuelling displaces all elements, the innermost dropping into a collecting chute in the central hole. The spent fuel will be ignited and the uranium oxide dissolved for reprocessing. A portion of the coolant stream will be filtered and purified to prevent accumulation of fission products. The outlet temperature was selected to suit the requirements of a process of the US Bureau of Mines for the gasification of coal, which may be a possible future application of a turret reactor. (Turret—A High Temperature Gas Cooled Reactor Experiment with Unclad Fuel, by R. P. Hammond *et al.*, 1959 ANS Winter Meeting, paper 14-4.)

Nestor: Details of Design

Last week it was announced that the UKAEA has purchased from Hawker Siddeley a modified version of their research reactor Jason, to be named Nestor. The Argonaut-type reactor was selected because of its suitability as a neutron source, in particular the fact that four vertical faces of the core are unencumbered by auxiliary equipment, and the top is free for independent water experiments. Other advantages are that the plate type fuel elements are in production in Britain and that the core layout lends itself to mechanised fuel loading arrangements. Fig. 3 shows a cross-section of Nestor, incorporating the proposed modifications to the original Jason design. The modifications arise out of the need to operate the reactor at the 10 kW level for extended periods, and involve screening of the control mechanisms from radiation, aluminium canning of the graphite wedges within the core, forced ventilation of the core and the experimental rooms to prevent argon concentration, and certain elaboration of the control gear for continuous operation. The shielding can be dismantled and rebuilt to admit new experimental facilities, and removable stepped blocks are also provided for access to instruments and the insertion of samples. The experiments can be partially isolated from core radiation by means of shutters composed of lead, polyethylene and cadmium sheets. The shutter enables the neutron irradiation to be started or terminated at will during reactor operation, making the various experiments partially independent of each other. (The Proposed Use of an Argonaut Core as a Neutron Source for a Reactor Physics Subcritical Investigation Programme, by G. W. K. Ford, J. R. Griffin and J. R. Harrison, 1959 ANS Winter Meeting, paper 7-7.)

Notes and News

The Winners: Organic Cooled and Boiling Water

As forecast in our Leader of 23 October, commenting on the Galbraith Committee's delay in announcing its decision, the organic moderated and cooled, and the boiling water types have been recommended to the Government as the most immediately suitable ship reactors for further development, it was reported recently. The organic moderated reactor was submitted by Hawker Siddeley, while boiling water reactors were proposed by both Mitchell-Fairfield and AEI-John Thompson, the former with closed cycle, the latter with direct (open) cycle operation (Atomic Review, 15 May, '59). There is no indication as yet as to which of the boiling-water reactors the committee favours, and a public announcement is not expected for some months. But it is likely that even the group proposing an open-cycle design will initially build a closed-cycle reactor with primary and secondary steam circuits. It is also of interest that, since the first proposals were submitted, the English Electric Company, through its agreement with Atomics International of North American Aviation, have put forward an organic moderated ship reactor design. It is speculated that the Government will ask for new tenders from all interested parties restricted to the reactor type or types finally chosen. If no further delays occur, Britain's first nuclear surface ship, probably a tanker or dry cargo liner, could be in operation in three to four years time.

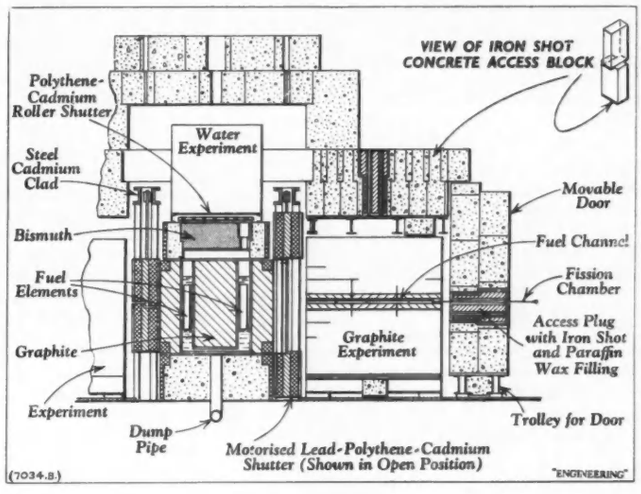


Fig. 3 Movable shutters isolate the experiments from the core in the new UKAEA neutron source reactor Nestor. The left radiation shutter is shown closed, the right fully open.

Second Nuclear Submarine Possible

The Admiralty are considering construction of a second nuclear submarine. Although Mr. C. I. Orr-Ewing, Civil Lord of the Admiralty, spoke of a "sister ship to Dreadnought," this does not necessarily mean that the reactor will again be of foreign manufacture.

South African Uranium and World Overproduction

Longer contracts give South African mines a better chance to survive the coming cut-backs in uranium purchases than their Canadian competitors. In many mines uranium is a byproduct of gold extraction, although in some cases the roles of gold and uranium have been reversed. The Bureau of Mines is believed to be considering plans to stretch out delivery commitments along the line taken by Canadians. (Atomic Review, 20 Nov., '59.)

Candu Site Announced

Of several properties on Lake Huron for which AECL had taken an option, a 2,300 acre plot has been selected between Kincardine and Port Elgin as the site for the 200 MW(e) station Candu (Atomic Review, 23 Oct. '59). Cooling water will be drawn from Lake Huron, and shore conditions at the site have been found favourable for the withdrawal of 300,000 gallons per minute. Nearest transmission facilities to link the output of Candu to Ontario Hydro's electrical network are at Hanover, only 30 miles from the selected site.

Welding Causes Delay at Chinon

Welding of the 4 in steel plates making up the pressure vessel of the EDF-1 reactor at Chinon is causing difficulties which will delay the construction schedule of the station by one year. The heaviest plate so far proposed for site welding by British consortia is 3½ in at APC's Trawsfynydd; but the limitation on weld thickness is thought to arise from radiography rather than welding.

Joint Projects for Russia and USA

It was hoped that the exchange visits of Mr. J. A. McCone, chairman of the USAEC, and his opposite number in Russia, Professor Emelyanov, would result in some agreement on the freer exchange of scientific information. It is now announced that McCone and Emelyanov have agreed to propose to their governments an exchange scheme of experts on all fields of nuclear research, including the fusion bomb, and joint construction of a particle accelerator was mentioned as a possibility.

More Fast Breeder Experiments at Argonne

Further expansion of Argonne's fast breeder development programme is reported. Following criticality of the fast source reactor AFSR, reported in Atomic Review on 20 November, construction of three new facilities is announced. Two zero power critical assemblies ZPR-6 and ZPR-9 will be used to measure the parameters of various fast reactor cores, and will share the experimental load with a similar facility, ZPR-3, operating at the Idaho Testing Station. The third new reactor at Argonne will be Juggernaut, a light-water research tool for the testing of instruments. Slow and fast neutrons will be available from the 250 kW(t) reactor through two graphite columns and numerous experimental openings to the core. (References to the ZPR series of test facilities, including the two-zone fast-thermal reactor ZPR-5 appeared in Atomic Review last 13 March.)

Neeratom Bidding for Italian BWR Components

Reactor vessel, heat exchangers, condensers and instrumentation may be supplied by Neeratom, the Dutch nuclear engineering consortium, for the boiling-water reactor of Senn to be constructed in Southern Italy. Neeratom have been approached by General Electric, designers of the station, and preparatory work is in progress, although no firm order has so far been placed.

Exchange on Advanced Gas-Cooling

Experience with the design, construction and operation of the advanced gas-cooled reactors at Windscale and Oak Ridge will be exchanged between the United Kingdom and the United States atomic energy authorities under the terms of an agreement signed on 16 November. The information will also be made available to interested industries in both countries.

Atomic Power in India by 1965

India's first nuclear power station will be in operation by 1965. The station, of unspecified type, will be built on the coast between Ahmedabad and Bombay and will supply 225 MW to the electrical grid. The Indian Atomic Energy Commission estimates that the installed cost will be around £127 per kW.

Facts and Figures for Europe's Future

Factual analysis of tariffs in the European Free Trade Area and the European Economic Community show that Great Britain has not struck the best bargain. Certain decisions of EEC may bring agreement between the blocs and promise for Commonwealth trade.

Fear that the two European trade blocs may drift further and dangerously apart, has brought the United States Under-Secretary of State for economic affairs, Mr. Douglas Dillon, flying to London. In the same week, Political and Economic Planning have produced a survey of the tariffs and trade of Western Europe which provides the facts necessary for informed opinion.

That individual members of the European Economic Community derive greater benefits from their membership than Britain will from her European Free Trade Area emerges from these closely detailed tables of tariff percentages and import values. Yet the report—*Tariffs and Trade in Western Europe*, George Allen and Unwin, 30*s*—does not tell a wholly pessimistic tale. On quite a range of manufactured goods the United Kingdom's most favoured nation tariff is close to the common tariff established by the European Economic Community and in some is lower than French or Italian tariffs.

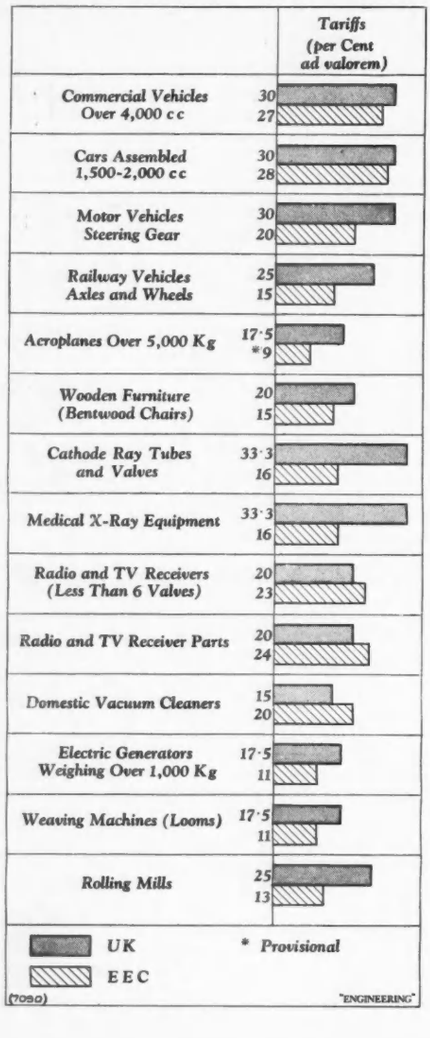
One of the rocks on which the British attempt to bring about a general European Free Trade area foundered was her obligation to maintain the free entry of raw materials from the Commonwealth. If any future negotiations, whether originating from Washington, London or Professor Hallstein, are to succeed in bringing the six and seven together this point will still have to be met. *Tariffs and Trade* shows that about four-fifths of British imports from the Commonwealth enter duty-free, as do a considerable number of these items which enter the European Economic Community. Those that do not are on List G, a special List on which EEC is negotiating the future external tariff rather than fixing an average. As much as 15 per cent of all EEC imports are accounted for by List G.

A possible indicator for the future here is the fate of softwoods. They make up the largest single Common Market import from outside the six and it appears that the working party in this case favours a low tariff policy.

In the division, "wood in the rough," *Tariffs and Trade* shows that none of the European Free Trade Area countries, Denmark, Norway, Sweden, Austria, Switzerland or Britain, imposes any tariff on pine, spruce and aspen logs, except for a one per cent tariff by the Swiss. Apart from Italy's 15 to 18 per cent, none of the European Economic Community has a tariff in this division. The List G tariff on this sector of softwoods is one to three per cent.

Other parts of the softwood tables show the List G figure as one of a low tariff policy, generally only a fraction of the Italian tax, and in some cases well below the Austrian.

Obviously if the Common Market authorities come out with generally low tariff decisions on List G, then some of the difficulties over Britain's Commonwealth Preference would be solved.



BENEFITS

With the bringing into effect of the common European Economic Community's tariffs, Britain will have the highest average "most favoured nation" tariff of the major European states. Correspondingly the European Free Trade Area members will get the benefit in their exports to this country, where they will still have to compete with free entering Commonwealth concerns. Since over a wide range of manufactured goods the other EFTA members charge very low tariffs or none at all, the advantage for Britain will be very much less. On the same note it is to be observed that while Germany and Benelux have been relatively low tariff areas providing the best markets for exports from EFTA, their duties will be raised considerably in the process of averaging throughout the EEC.

This can be seen in the tariff figures for electric machinery where generators and motors weighing over 1,000 kg at present attract no duty going into Germany and 8 per cent into Benelux. These are to be replaced with the EEC tariff of 11 per cent. Manufacturers can perhaps derive comfort from the other side of this particular coin, which is that the French tariff will come down from 20 and the Italian from 11 per cent.

There is a similar development in the tariff on cars. The German tariff on cars of under 1,500 c.c. is 17 per cent and the Benelux tax 42. The new EEC figure will take these up to 29, and at the same time bring the Italian tax down from 45 and the French down from 30 per cent.

For the struggling aeroplane manufacturers there is much the same story: no tariff at all now into Germany or Benelux, 20 per cent into France, and 15 per cent into Italy on aircraft of over 5,000 kg. The EEC List G tariff is given as 9 per cent, which is still well below the British tax of 17·5 per cent.

Aircraft are a good example of a field where, apart from a Norwegian tariff of 12 per cent through the three weight categories and that for parts, and Britain's 17·5 per cent, none of the EFTA countries charge any tariff at all.

A state of ideal free trade exists in ships and boats where nought per cent is the tariff of all the EEC and EFTA states, except land-locked Austria which has a tax of 20 per cent.

So far as the differences between EFTA tariffs and those of EEC will be the substance of future getting-together talks, and they must form at least part of any such agenda, the tables of *Tariffs and Trade* show the EEC and the United Kingdom taxes moving closer together in electronic calculating machines; EEC 14 per cent, UK 17·5. The EEC figure is a substantial drop for France and Italy but only a 2 per cent rise for Germany. Other EFTA states have 5 or 10 per cent tariffs.

In machine tools, where the UK import tax has just come down from 17·5 to 10 per cent there is a state of flux in the EEC. The category is on List G where provisionally the tax is between 5 and 13 per cent. At the moment the German figure is 0 to 6 per cent, the French 6 to 22 per cent, and the Italian 7 to 20. Machine tools are one of the examples where the UK tariff is below some of the EFTA rates in an industrial sector. Norway has a tariff between 0 and 20 per cent, and Austria 25 per cent.

ANXIETY

Quite rapidly during 1960 a progressive decline in the tariffs charged with in each group to its own members will set in, and EFTA countries will lower their tariffs by 20 per cent for each other on 1 July, 1960, the same date as EEC members carry out their second 10 per cent cut. It is these intra-community lower levels that may play so significant a part in the pattern of each state's trade. In the differentiation against non-group members including non-Europeans as well as members of the "other" area, lie the seeds of anxiety for world trade as a free and healthy whole, trouble which is in the minds not only of those territorially involved, but of the Americans as well.

The SIX members of the European Economic Community (EEC) are the Benelux countries, Belgium the Netherlands and Luxembourg, together with Federal Germany, France and Italy. EEC is often referred to as the Common Market.

The SEVEN members of the European Free Trade Association (EFTA) are Austria, Denmark, Norway, Portugal, Sweden, Switzerland and the United Kingdom.

Western European Tariffs on Selected Industrial Products (*Per cent ad valorem*)

	Den-mark	Norway	Sweden	Austria	Switzer-land	UK	Germany	Benelux	France	Italy	EEC (est.)
Cars under 1,500 c.c. ..	14	30	15	20	14-23	30	17	24	30	45	29
Electric hand tools ..	7½	15	10	21	1-3	17½	4	12	20	22	14
Radio and TV receivers	17	25	17	38-40	7-14	20	15	20	24	25-35	21-23
Bulldozers, not less than 180 h.p.	5	10-20	10	10-15	2-9	15	0	8	20	30	14
Box cameras	7½	12	5-10	n.a.	1½-4	40	6	15	25	25	18
Polyvinyl butyral ..	0-7½	30	10-15	0	3½-6	10	19	12	30	30	23
Penicillin	0	0	0	20	1-4	33⅓	21	12	15	35	21
Woven fabrics of wool ..	12½	18	14	14-18	8-17	17½	12	18	15	20	16

The above items are taken from the PEP Report *Tariffs and Trade in Western Europe* which contains a tariff comparison for the EFTA countries (except Portugal) and the EEC countries, for over 1,000 important items of trade. The tariffs for the EFTA countries are as at early 1959. The tariffs for the EEC are the rates at 1 January, 1957, i.e., those to be used in calculating the common tariff. The common tariff except where negotiated, is to be the arithmetic average of the rates of the four tariff areas of EEC, and an estimate of this is shown in the last column. Only most-favoured-nation rates and not preferential rates are shown. Denmark is now in the process of changing its tariff.

Special Article

Functionalism Built into a Fighting Ship

HMS Hermes, the latest aircraft carrier to be commissioned in the Royal Navy, has been described as a "push-button" ship. She is equipped for remote control of the engines and boilers and carries very advanced radar.

Dominated by an unusual radar antenna, HMS Hermes carries sophisticated control gear.

Built by Vickers-Armstrongs (Shipbuilders) Limited, Barrow-in-Furness, Hermes is 741 ft 6 in long, has a beam of 144 ft 6 in, and a displacement of about 22,000 tons. Her armament consists of ten 40 mm anti-aircraft guns in twin mountings, all radar controlled. She shares with HMS Victorious the distinction of having the finest operational equipment of any aircraft carrier in the Navy. Laid down at the end of the war, the ship was launched in 1953, and has now been formally handed over to the Admiralty; the long period of time between the laying of the keel and the commissioning is accounted for by the fact that construction was suspended so that many new technical features could be incorporated. Actual construction time was, in fact, about 4½ years. Hermes may be the last British carrier to have conventional propulsion machinery. No aircraft carriers are being built for the Royal Navy at present, and it is possible that any such ship constructed in the future will be propelled by nuclear power. The American Navy's Enterprise, now under construction, will have eight nuclear reactors.

Remote Control

The propulsion machinery of the present ship, though it is basically orthodox, consisting of steam turbines and oil-fired boilers, is particularly interesting in view of the degree of automatic and push-button control which has been incorporated. A central control room enables the engines to be run without any personnel in the engine room, control panels making it possible for the starting, stopping, reversing and speed to be controlled by one man, under direct orders from the bridge. In the same control room there are panels which enable the boilers to be operated fully automatically. Once the correct fuel-to-air ratio has been set, the control equipment takes complete charge of the boilers, making the necessary fuel and air supply adjustments according to the steam demand.

By means of this remote control equipment it is possible to evacuate the engine and boiler rooms if the ship has to pass through an area contaminated by an atomic explosion, and to remove the personnel to a place of safety, while retaining full operational control of the propulsion machinery. A further advantage of the automatic boiler control is that it is more sensitive and more consistent than a human operator could be, and in addition to providing an absolutely reliable control in times of emergency, should result in a measurable fuel economy during normal sailing. The cost of operating Hermes will be about £20,000 weekly.

Radar

It is in the advanced design of the radar equipment that Hermes is particularly outstanding. This equipment, which is similar to that installed in the Victorious, is of the type known as "3D," and gives information on the tactical air position continuously and simultaneously in three dimensions. The ship's radar makes it possible for control to be exercised over many more aircraft than she can carry, and cooperation with other ships is thus facilitated. Externally, the only unusual part of the radar system is the large antenna of distinctive shape which is carried on the island forward of the ship's funnel. It is clearly visible in the illustration. Internally, the equipment is very large and complex, and extends well below decks.

The high performance is obtained by making the radar produce a number of separate, narrow, pencil beams. One of these beams, which gives the long-range warning, is fixed in elevation as the antenna rotates. The other beams also rotate like the fixed one, and in addition, they scan separate vertical sectors in synchronism. As the sectors scanned are contiguous, the total scanned angle gives the vertical coverage of the set. From these scanning beams, accurate height, range and bearing information is obtained.

Radio-frequency power is produced on centimetric waves by several very high power magnetrons, one of which feeds a conventional type of fixed horn for the long range beam. The others feed scanner units of novel design, by which it is possible to avoid the use of rotating joints carrying radio-frequency power—a considerable problem at the high powers involved. Another feature of advanced design is the lens used to focus all the beams. By employing a lens, greater flexibility in aerial design was possible, bearing in mind that the large mass of the scanners would present a considerable obstruction to radiation from a conventional parabolic reflector. The diameter of the lens and its focal length are both about 14 ft, which gives an aperture of f/1. It is constructed by spot-welding together a large and intricate group of aluminium waveguides of differing rectangular cross-section and length. Each beam has its own separate receiver channel.

To reduce the waveguide losses to a minimum the transmitters and head amplifiers are housed within the antenna. The whole radar mounting was prefabricated and hoisted into position on the ship. It weighs about 27 tons, and is supported on a single deck ring.

Display System

The complete radar system is brought into action from a central control desk mounted below decks, and a very sophisticated display system is provided to enable the mass of information gathered to be used to the full. Provision is made for processing, storing and filtering the information and displaying it to the officers making tactical decisions, in the most comprehensive and comprehensible form possible. To this end, the equipment has been so designed that the men and the machine form a completely integrated system, tailored to suit the operational requirements.

One problem which arose in the design of the equipment was the requirement to display certain information in the form of written characters on the face of a display tube. Existing methods, such as television techniques or the monoscope, were rejected mainly because of their complexity and the fact that their principal components are rather fragile. Instead, a new system was developed, using various low-frequency waveforms, all derived from a fundamental sine wave of 1·4 kcs per sec. These waveforms consist of the fundamental and its second harmonic together with various derivatives produced by phase shifting and positive and negative rectification. By applying the waveforms in suitable combinations to the tube, characters are written.

It is possible to write all the alphabetical and numerical characters and a number of other useful shapes such as triangles and squares with a maximum of four wavelengths, even for the most complicated character. As the characters are formed by "writing" instead of scanning, the thickness of the lines is limited only by the spot size, and very small characters can be written quite legibly if required.

Aircraft

Hermes will carry Supermarine Scimitar strike fighters (mounting nuclear and cannon armament), de Havilland Sea Vixen all-weather fighters with Firestreak air-to-air missiles, Westland Whirlwind anti-submarine helicopters and a flight of Fairey Gannet airborne early warning aircraft. For oxygen supply to the aircraft the ship carries a liquid oxygen plant; she is the first British aircraft carrier to do so. There are two steam catapults on a flight deck which is angled at 6½°, and the normal mirror landing aids are carried.

XUM

Shipyard Reconstruction at Sunderland

Over the last 3½ years the East and West Yards at Southwick shipyard, Sunderland, of Austin and Pickersgill Limited, have been rebuilt without interruption to their shipbuilding programme. The work, valued at about £1,500,000, required the demolition of the old yards, construction of three new berths, a fabrication, welding and assembly shop, and a new fitting-out yard, including a deep-water berth to take ships launched from the new yards. Contractors for the work have been Holloway Brothers (London) Limited.

On the site of the old West Yard, which was largely covered by old berths, three new berths have been built, the largest capable of holding vessels up to 25,000 tons deadweight. Altogether the rebuilt yard will be able to handle 25,000 tons of steel a year, equivalent to nine ships of 10,000 tons deadweight. The new assembly shop has a floor area of 12,000 sq. yd and contains offices and ancillary workshops. There is also a steel stockyard with rail access.

A considerable amount of levelling and fill was involved in the site works. The fill was obtained from a hill that was originally formed out of the accumulated discharge of Thames ballast from the old sailing colliers returning light to Sunderland over the course of several hundred years. Heavy piling had to be laid under the new slipways, including 878 tons of steel piles, 599 Franki piles and 338 timber piles.

The work in this yard began in February, 1956; the first of the new berths was handed over to the clients in May, 1957, and the first ship from the new slipways was launched in April, 1958—the same month that civil work was completed in the yard.

Work in the East Yard began in November, 1957. There were three old building berths in the area and in one of them a ship was still on the stocks when the contractors went on site. A system of guyed derricks covered the whole working area, so a detailed working programme had to be evolved to avoid interfering with the shipbuilding.

The contract was for the demolition of old buildings and slipways, and the conversion of the area into a fitting-out yard and quay, including the deep-water berth. A quay wall 600 ft long was built along a new line after the removal of large quantities of spoil. For a length of 250 ft, as may be seen from the illustration, a quay deck has been built out in front of the wall, supported on the river side by concrete cylinders 4 ft 6 in in diameter. Two dolphins on similar cylinders built out in front of the quay provide berthing for ships at all states of the tide. Both the cylinders and the wall are founded on magnesium limestone; divers were used to help place the outermost row of cylinders for the dolphins.

Construction of the new quay wall and quay decking in East Yard completed. Dredging for the deep water berth is shown in progress and the dolphins in front of the main quay are partially built.

The site behind the quay wall was back-filled with 33,000 cu. yd of material to raise the ground level by 18 ft. On this reclaimed land have been built workshops of 81,000 sq. ft for joiners, pipefitters, blacksmiths, painters, shipwrights and other trades involved in fitting out ships. Offices and access roads have also been built. A 15 ton Stothert and Pitt electric travelling crane on the quay will serve ships moored for fitting out. (Installation of the crane was not part of the Holloway contracts.)

At low tide, the main berth has a depth of water of 18 ft and it is 210 yd long by 50 yd wide. To form the berth, 86,000 cu. yd of river mud and clay were removed down to bedrock by grab dredger and dumped out at sea; 2,150 cu. yd of rock were then blasted out.

In February, 1958, the ship on the old slipway was launched, whereupon the remainder of the old buildings and slipways were demolished. Up till that date construction of the quay wall had been under way but it was not until the site had been cleared that backfilling behind the finished portion of the wall could be begun. The motor ship Iron Ore was the first vessel to be moored to the new quay, on 10 August of this year; building work was so far advanced that fitting out began without delay.

The consulting engineers for all the work were R. T. James and Partners, of London and Newcastle upon Tyne.

Bridge Replacement Completed at Doncaster

The proportion of highway bridges in Great Britain being replaced each year is so small as to make any road bridge reconstruction of interest. Most recent of such work is the new bridge at Doncaster, where a lattice girder dating from 1899 and an adjacent lock bridge dating back to 1728—both too narrow and too weak for today's traffic—have been replaced by a welded steel structure with a reinforced concrete deck providing for four lanes of traffic.

Simultaneously improvements have been made to the river course to prevent flooding that used to follow heavy rain: some weirs downstream of the bridge have been removed and the river course has been straightened so that the top level has been lowered by about 10 ft. The cost of the river works has been borne by the Yorkshire Ouse River Board. Of the bridge itself, the northern section is part of the A1 trunk road and the cost has been met entirely by the Ministry of Transport. The southern section, which lies within the county borough of Doncaster, ranked for a grant from the Ministry. Design and supervision of the scheme has been the responsibility of the Doncaster Borough Engineer, Mr. Martin Cawley. Contractors for the scheme have been Holland & Hannen and Cubitts Limited, of London. The work was completed within the contract period of three years.

The new bridge has three spans and is built

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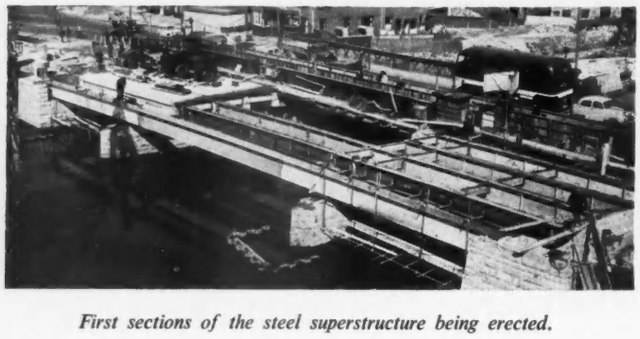


First sections of the steel superstructure being erected.

The completed bridge, with two 22 ft carriageways.

Case History of a Soil Investigation

A soil investigation made at a site in Bo'ness, Scotland, has provided the subject of a film by Foundations Limited, a member of the Richard Costain group of companies. The film—in technicolour and running for about 25 minutes—forms a case history of the investigation. It is called " The Problem Below."

It was planned to build on the area, which had been regained over the years from the Firth of Forth, blocks of 3 and 4 storey flats and maisonettes. Within the area there were remnants of old mine works and saltpans; the existing buildings showed distinct signs of heavy settlement. The architects responsible for the new work, Alison and Hutchison and Partners, called in Foundations Limited to make site borings and report. The film traces the progress of investigations: boring and drilling operations; handling of undisturbed samples and the routine laboratory tests; the parallel study of local records and assessment of the problem; and an explanation is offered of what was revealed by the investigation, together with an indication of the recommendations made to the architects.

Elevated Motorway Competition: Results

Elevated highways are one of the best ways of curing urban road ills. For this reason the Prestressed Concrete Development Group organised a competition for an elevated motorway design. The results were declared last week and the first prize of £500 awarded for a joint entry by Mr. W. F. G. Crozier, Mr. J. D. Bennett and Mr. C. G. Kerry, all of Guest, Keen and Nettlefolds Reinforcements Limited, Knightsbridge, London.

Four other awards were made, one of £200 to Mr. E. O. Measor of Scott and Wilson, consulting engineers, in collaboration with Mr. A. Bailey, consulting architect; and three other awards of £100. A total of 25 entries was submitted and, in addition to the five that received prizes, three others were considered worthy to be presented in the exhibition that the Group are arranging at the Institution of Civil Engineers between 13 and 22 January, 1960.

In their report the assessors comment that there was no " outstanding submission which, while being aesthetically good, was also adequate in structural design, in arrangements for traffic flow and ease of construction. The safety of pedestrians using the lower road has generally been ignored and little thought has been given to the problem of expansion joints in the wearing surface."

The competition was successful in obtaining entries from overseas and one of the £100 awards goes to Dr. U. Finsterwalder and Ing. E. Paulus. Their design was both structurally and aesthetically satisfactory but the erection was considered by the assessors to be difficult since the whole structure was of *in situ* concrete forming a prestressed mushroom. The other designs all made use, in varying degrees, of prefabricated members.

The other two awards of £100 went to Mr. F. Graham of Brandt and O'Dell, and to Mr. R. W. Hobbs of Ove Arup and Partners.

Fire Protection of Buildings

Three booklets relating to the fire protection of buildings have just been published: *Flame-Retardant Building Materials*, HMSO (1*s*); *Good Practice in the Fire Protection of Buildings*, Fire Protection Association, 31 Gresham Street, London, EC2 (2*s* to non-members); and *Fire-Resistant Construction in Modern Steel-Framed Buildings*, Technical Bulletin No. 16 published by the Canadian Institute of Steel Construction, 388 Yonge Street, Toronto (no price given).

The first of these three booklets, prepared by the Joint Fire Research Organisation of the Department of Scientific and Industrial Research, lists the proprietary products that have been tested at the Fire Research Station and which satisfy the requirements of appropriate specifications.

The Fire Protection Association's booklet sets out in straightforward manner for engineers, architects and builders the general principles of fire-resisting construction, illustrating the points with small sketches. Detailed recommendations are given for the fire resistance required for various structural elements, such as fire-separating walls, floors, columns and beams. The fire-resistance grading of most of the common structural elements are given in a series of tables.

Lightweight fireproofing is having a marked influence on the design of steel framed buildings. Gypsum, perlite and vermiculite, mineral fibres, concretes and masonry generally can all be used to protect steelwork, but the advantages possessed by the lightweight materials offer much for the future, particularly when they can be sprayed into place. The possibilities are discussed and well illustrated in the bulletin of CISC. At the end of the bulletin fire-resistance ratings are given for different construction elements which are detailed in dimensioned drawings.

The Tragedy of Malpasset Dam

A simple mistake in the calculations or evidence of shoddy workmanship, by known standards, are unlikely to be the findings of the inquiry into the tragic failure with such great loss of life of the Malpasset dam in southern France.

The dam was a circular arch of slender construction—only 22 ft 6 in thick at the base and not quite 5 ft at the crest, despite its 197 ft height. This thin arch form is by no means unproved and M. André Coyne, a former president of the International Commission on Large Dams, who designed Malpasset, has been responsible for others of a similar type. Likewise, the contractors for the dam had also undertaken similar work. There can be no fears that the rock surveys would have failed to have shown any recognisable weaknesses.

Reports indicate that the reservoir filled quickly during the last few days of heavy rain. The opening of the flood gates was delayed for fear of damaging some half-completed bridge and road works downstream.

Two considerations arise. First, could the gates—which were well under water—be opened so quickly that eddy currents were produced that had a devastating effect on the back of the dam, sucking the concrete away from the rock face? On the east bank, where the wall was torn clean away from its foundations, the rock is said to be a friable schist and therefore unable to withstand such a tearing force. The design would have taken into account the thrust of the arch normal to the crystalline planes in the rock, but would the effects of a negative loading have been taken into account? Suppose also that the water released had more than threatened the new works, or even houses, downstream: might there not have been an urgent 'phoned command to close the gates? And what if they were closed quickly? Such action may well have set up repeated shock waves that bounced off the rock faces to pound and suck at the back of the dam.

The Möhne dam—a mass gravity dam 25 ft thick at the crest and 112 ft at the base—was destroyed during the war, not by the explosive force of the bomb, but by the shock waves created in the water.

Concluding Bridge Replacement

as a balanced cantilever with a central suspended span. The middle span is 61 ft long between piers and the side spans each 34 ft; the bridge is built on a skew of 77° and carries two 22 ft carriageways with a 6 ft central dividing strip and two 10 ft foot-paths.

Ten welded steel girders form the bridge superstructure, spaced at 7 ft centres and stiffened by cross girders. This arrangement provides for two parapet girders, a girder under each of the four kerbs and two more under each carriageway. There are slight curves on the soffits of the main girders, giving a rise of 9 in at the centre and 6 in over the piers. The main girder is 2 ft 11 in deep overall with $\frac{1}{2}$ and $\frac{5}{8}$ webs, and $1\frac{1}{4}$ in flange plates, 18 in wide, of notched ductile steel at the centre. Movements of the bridge due to live load and temperature changes are allowed for by rocker bearings.

The main bridge girders were prefabricated and the cross girders site welded. All the workshop welds were examined by gamma radiography and site welding was checked by magnetic crack detection. The sub-contractors for the steelwork were Dorman Long (Bridge and Engineering) Limited.

Temporary sheet steel pile cofferdams were sunk to ease construction of the piers and abutments and subsequently cut-off underwater after completion of the work. The foundations are bored concrete piles, 18 in diameter and about 30 ft long, bearing on 80 ft red sandstone. Below each abutment there are 80 piles and under each pier 60 piles, most of them having a rake of 1 in 10. Both the piers and abutments are of reinforced concrete faced with York stone of alternating 8 in and 12 in courses. Within the cofferdams, two courses of stone were laid prior to concreting each lift.

The concrete was specified as a 5 to 1 mix by weight to have a minimum 28 day strength of 3,300 lb per sq. in. The mix actually used had an aggregate/cement ratio of 6·5 to 1, a water/cement ratio of about 0·5 and gave an average 28 days strength of 4,300 lb per sq. in.

Reinforced concrete, 9 in thick and spanning across the main bridge girders, forms the deck. A hot-rolled asphalt surface was laid on the carriageways, applied in two layers of $2\frac{1}{2}$ in and $1\frac{1}{2}$ in, and a $\frac{3}{4}$ in precoated chippings were rolled into the top layer. All the services—gas and water mains, electrical power and lighting and telephone cables, are laid in ducts below the pavements and the central dividing strip. The services are packed in sand.

To complete the scheme, an improved northern approach has been built which includes an oval roundabout having axes of 185 ft and 110 ft.

Protection for a Crude Oil Pipeline

Construction of Britain's longest crude oil pipeline has been completed. It is 60 miles long and will link British Petroleum's tanker terminal, now being built near Angle Bay, Milford Haven, and the company's Llandarcy refinery, near Swansea. The capacity of the pipeline will be 5 million tons of crude oil a year. The first tanker to deliver oil at the new terminal is expected to berth early in the second half of next year.

Work on the pipeline has taken just over a year. More than 10,000 pipes of 18 in diameter and 25 ft long have been laid. After being welded together the pipes were wrapped in glass fibre and bituminous enamel. The pipeline is buried and care has been taken to preserve and restore the countryside. Four major rivers, five minor rivers and 28 streams are crossed by the pipeline; there are also more than 100 road and 12 rail crossings.

Brake Fade Reduced With Combination Drums

The Pontiac division of the General Motors Corporation, Pontiac, USA, have announced a new and " radically different lightweight wheel-brake drum " which is said to eliminate fade-out and to add 50 per cent or more to braking life. A new concept in braking efficiency, the integral wheel drum is made with a cast-iron friction liner for braking, molecularly bonded into the heat-dissipating casting by the use of a process developed by the Al-Fin division of the Fairchild Engine and Airplane Corporation.

An announcement that Pontiac would make the new system available on all models in 1960 was made by the general manager of General Motors' Pontiac division. Their adoption of this technique follows exhaustive testing by dynamometer, both on proving grounds and under severe mountain driving conditions. In this connection, the Buick division of General Motors standardised on separate bonded bi-metallic brake drums for all models in 1958 and Pontiac adopted them for heavy-duty vehicles, such as taxi cabs, police cars and ambulances, in 1959.

The integral wheel-drum is 2 lb lighter than the combination of steel wheel and hub cast iron drum which it will replace; thus reducing unsprung weight and resulting in smoother riding qualities. With the new construction, the separate steel rim which carries the tyre is attached by a scolloped spider to a 10 in bolt circle on the outside diameter of the wheel drum, as compared to the usual 5 in bolt circle on conventional wheels. The relatively small area of contact at only eight points between the wheel and the rim, and the air flow between the two, reduces considerably the transfer of heat into the tyres so that they run more cooly under severe braking conditions.

When rigorous braking conditions occur, as in mountain driving or in heavy traffic on fast roads, the maximum temperature of the aluminium unit is at least 100° F lower than the temperature of the conventional cast-iron drums at present used with stamped steel wheels. Tests of such one-piece wheel drums have shown this arrangement to be fade proof even after 40 consecutive 15 ft per sec per sec stops from 60 m.p.h.

Panic stop tests on the new type units have provided " unbelievable " improvement with respect to brake fade and recovery, according to Pontiac. Fading is normally caused by reduction of lining friction and bell mouthing due to excessive frictional braking heat, in reservoir-type cast iron drums; so that the brake shoes make only partial contact with the drum face. The aluminium wheel-drum unit will be affected less by loss of friction lining and bell mouthing than the cast-iron drum, as a result of its lower peak-operating temperature. Because of the latter feature, the brake lining does not break down as quickly as with cast-iron drums. Consequently, lining life is greatly extended and drum scoring is markedly reduced.

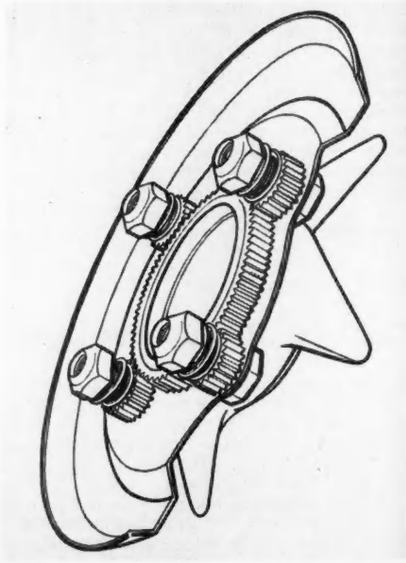
Since they are made primarily of aluminium, which has four times the heat transfer coefficient of ferrous metals, the unit acts as a heat sink; the heat being almost instantaneously conducted through the entire mass of metal owing to its high thermal properties. In the conventional cast-iron and steel construction, the temperature builds up rapidly on and near the friction braking surface because of the poor thermal conductivity of cast iron. While the average temperatures may be slightly higher in the new aluminium unit, the peak temperatures are lower. Aluminium does a better job in the final analysis because of the large exposed area that heats rapidly, and this temperature difference over a large area is essential for quickly dissipating the braking jet to the air.

The styling advantages of the unitary wheel-brake drum are somewhat desirable since the design can be easily cast in permanent mould to the configuration required by the stylist. The aluminium drum head with integrally-cast fins is exposed and adequate cooling is obtained from the natural air flow round the wheel. A high pressure area is built up under the car by its forward motion, and the pressurised air is forced out between the wheel-drum and the rim increasing dissipation of the braking heat.

The secret of the success of the bi-metallic construction lies mostly in the patented molecular bond between the cast-iron friction surface and the cast aluminium wheel-drums, which permits the generated braking heat to flow freely through the metallic bond (without a measurable temperature drop) into the aluminium structure where it is dissipated into the air. In contrast, if there is no bond, as would be the case if the cast-iron liner were merely cast or pressed into the aluminium structure, a decided temperature drop occurs across the interface. The minute gap between the two metals, plus the presence of oxide normally found at the interface of unbonded metal joints, acts as a heat barrier and prevents a maximum transference of heat.

Furthermore, the resistance to heat flow increases in an unbonded joint during its service life, owing to the separation due to the deformation of the aluminium under heat cycling and because of the different coefficients of expansion of the dissimilar metals; a build up of the oxide film; and to the entrance of foreign matter into the gap. Heat transfer, therefore, becomes increasingly worse as time goes on. This, apparently, cannot happen with " Al-Fin " bonded construction as dissimilar metals are " molecularly " joined and they expand and contract as a unit under heat cycling. The strength of the bond prevents their separation and the intermetallic joint permanently maintains its initial high degree of conductivity.

The new bi-metallic construction is a concept developed independently by the Kaiser-Aluminium and Kelsey Hayes companies, in collaboration with the Al-Fin division of the Fairchild Engine and Airplane Corporation. Pontiac's production requirements for the new units, which are made in full permanent mould, will be supplied by the Kelsey-Hayes company, which is one of 52 firms, in some twelve different countries, licensed to use the Al-Fin process.



Bolt-on Wheel Conversion

British engine tuning specialists, the Alexander Engineering Company Limited, have evolved a quick method of doing up and undoing wheel nuts with a hammer, just like a centre lock wheel.

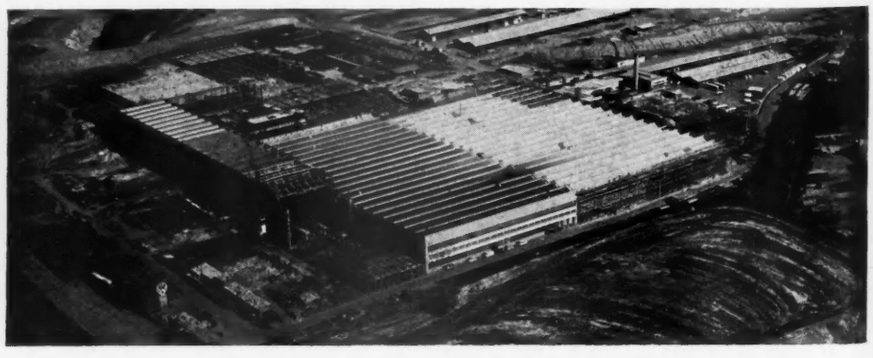
It consists of an ornamental plated hub plate carrying a three-eared knock-on hub nut. On the other side, this nut is attached to a gear wheel which engages with four small planet gears attached to the wheel nuts. There is no more fiddling with separate nuts. They are unscrewed in a few seconds by a few taps with the fibre-headed wheel hammer. To put the nuts back, any two are engaged with the threads of the wheel bolts and then the centre eared nut is turned with the hammer. Connection between each wheel nut and its drive gear is arranged to slip at a pre-set torque, so that if one nut tightens before the others, its drive " free-wheels " until they are all tight and no damage is done to threads.

The first series are four-nut caps designed for cars like Morris Minor 1000, Austin A.40, Riley 1500, Wolseley 1500. Price in small quantities is fairly high; nearly £20 for a set of four complete with wheel mallet.

Volkswagen in Brazil

The new Volkswagen factory in Sao Paolo, recently opened by the President of Brazil, is producing 2,000 units a month, using 84 per cent Brazilian material and 100 per cent local labour. The factory is shown in the aerial view.

In six years since its foundation, the Brazilian Volkswagen subsidiary has progressed from assembly towards complete manufacture and now employs 3,400 people. In paying tribute to the diligence, discipline and adaptability of Brazilian workmen, Dr. Nordhoff, director general of Volkswagen, stressed the importance of the support such a factory gives to ancillary industries: " We have found that an automobile factory's sales and service organisation employs as many people as does the factory itself and in the final stages of development the suppliers employ the same number as well."



Steel on the Mend

The removal of the threat of re-nationalisation and the widespread expectations that dividends are about to be liberalised has led to an unprecedented interest in steel shares at the start of the steel company dividend season. The fact that South Durham Iron and Steel Company failed to raise their dividend has not seriously affected the market's hopes. Investors' expectations have been heightened by the approach to full capacity working illustrated by the October figures. In some sectors a shortage of capacity has emerged, particularly in alloy steels and motor body sheet. Others are expected to develop as the general industrial recovery continues and eventually to spread to the heavy section and plate section of the industry, which has been by far the worst hit by the industrial recession.

Results in respect of the financial year ended recently are unlikely to prove very good, since most of the large companies have been working under capacity. Recent remarks by the chairman of BSA, Mr. J. Y. Sangster and the chairman of Tube Investments, Sir Ivan Stedeford, suggest that the recovery has not yet gone far enough to enable a definite forecast of results during the current year. Mr. Sangster spoke of an improvement in orders for special steels but said that there remained an acute shortage of orders for heavy steel forgings and castings for the capital goods industries. Tube Investments report that the decline in overall demand in the first quarter of 1958/59 persisted into the spring of 1959 and was particularly severe in the steel tube division, involving a reduction in requirements from the iron and steel division. The recovery which set in towards the end of the group's financial year, however, has been maintained into the current year "and has since gathered momentum."

The profits of South Durham Iron and Steel Company for the year ended 30 September were 10 per cent higher at £7·84 million. The decision to maintain the dividend at last year's level was doubtless influenced by the heavy capital expenditure to which the company are committed for their expansion programme. Prospects have improved and the company's position should be further strengthened during the current year.

New Products from Europe

Licences to manufacture European designs have been secured by two companies each engaged on a policy of diversification. The Bestwood company have concluded a licence agreement with Klockner-Humboldt-Deutz AG of Cologne whereby their subsidiary company, Plowright Brothers, of Chesterfield, are granted the exclusive rights to manufacture in Great Britain the Humboldt patent "sink and float" coal washing plant. This will fit in well with the activities of Plowright's coal preparation and carbonisation division in London and with the facilities available at the company's factory in Chesterfield.

An association with a French company, Soudure Electrique Languepin, was announced by the chairman of Solar Industries in his statement to the company's annual meeting. Languepin are one of the leading French manufacturers of welding machines and specialists in the design and development of large multi-head machines for the welding of motor car bodies, and of the associated transfer machines and other automation equipment. A joint company, Solar Weld Languepin, has been set up "to further the proposed collaboration" in these developments and in the production of spark erosion machines.

Solar Industries' performance during the year ended 30 June showed a marked improvement over the previous year. Trading profits were 30 per cent higher, at £476,700 and further progress has been made during the current year in most divisions of the group. Their chairman, Mr. R. K. Calder, forecast "further records" and commented that the all-round increase in output and profits so far was most satisfactory. The group's principal products are non-ferrous metal castings, agricultural machinery, and motor vehicle and aircraft components.

Catagunya to Nant-Y-Moch

The Cementation Company has spread its civil engineering interests so widely over the world that its fortunes amount almost to an index of basic investment on the widest scale.

From Eastern Canada to New Zealand and from Brazil to Cashlie, in Scotland, the group is either currently active or ready to take advantage of the first improvement in conditions. The major civil engineering contracts in Britain for the group are those at Ffestiniog and Nant-y-Moch in North Wales and at Cashlie. While mining operations have continued at a high level in this country they cannot be expected to continue in view of the current decisions of the National Coal Board, and restricted activity is anticipated after the present programme of shaft sinking has been completed. Overseas prospects in this field are being investigated with greater effort.

Cementation acquired, during the year under review in the annual statement of Mr. A. R. Neelands, the chairman, the patent rights for the Commonwealth and certain other countries of the process known as Vibroflotation. This method increases the density and hence the load-bearing capacity of granular materials for which other methods are not suitable. It is now in use by the company both abroad and for the Atomic Energy Authority at the site of the new Winfrith Heath research station. Adding to their specialisations work in soil stabilisation, the company are employing this method of soil compaction in contracts in Kenya and Rhodesia and is finding that interest is being shown from surrounding territories.

The Cementation department is currently working on contracts at the foundations of the Alexandra Bridge, British Columbia, the exploratory work on the Cameron Highlands hydro-electric scheme in Malaya, dam stressing at Catagunya in Tasmania, stabilisation work at Guma in Sierra Leone and at home, and consolidation of alluvium at the site of the new Blackwall Tunnel, London.

The company is facing the need to find new departures for its operators and equipment in exploratory drilling. Back in 1941 the Ministry of Fuel and Power wanted contractors able to undertake such work on a large scale for opencast coal. Cementation has played a large part in this right from the start, drilling a total of almost nine million feet in England, Scotland and Wales. Now this period is coming to an end and these resources will need overseas work if they are to be actively deployed.

Part of the overseas development has included the opening of a branch office at Lagos. In India, which remains the largest source of overseas work directed from the United Kingdom, a useful level of turnover is expected for years ahead, though local taxation is still heavy and the work at Durgapur has not much more than a year to run.

While home policies affect the drilling interests, international economic trends react as quickly on the group's Geophysical Group companies. The fortunes of this group fluctuate with the developments, in the main, of the oil and mining industries. The volume of work suitable to geophysical methods has decreased in recent years while the competition has been stepped up. At the same time a costly organisation and valuable equipment has been maintained in order not to be left standing by improvements in world business conditions. Although last year's Geoprosco results were disappointing, Mr. Neelands looked forward to improving conditions in the businesses on which the group is dependent.

To take only two of all the other interests of Cementation in South Africa, Canada, Spain, Brazil, Kariba (Rhodesia), New Zealand and Portugal: turnover in Brazil has been limited by import difficulties which the company has been meeting by acquiring and equipping workshops in which to make locally the specialist equipment they require. This manufacture has now begun and with it the expansion which is the group's recurrent theme. The associated company Les Travaux Souterrains' is busy building the future—deep drilling for oil in the Sahara.

Rover Report

The Rover company's change in models to the distinctive 3-litre car and the radical changes which brought about the Rover "80" and the "100" disturbed the company's performance in the car markets last year as other similar changes had done in the previous year.

No such alterations are planned for this year and accordingly Mr. S. B. Wilks, chairman of the Rover company, was able in his annual statement to look forward, supported by a strong order book, to the future success of these cars. The discussions the company has had in the past year with Willys Motors and with the Standard Motor company, which in the event led nowhere, are recalled by the chairman who affirms his confidence in Rover's ability to maintain its position in the motor industry and to expand within its own organisation.

Strengthening their overseas hand, represented by companies in Australia and South Africa and the subsidiary in North America, Rover are to form a subsidiary in New Zealand for the assembly of Land-Rovers.

Mr. Wilks comments that for all the general view that the future for the motor industry and for all industry appears to be one of expanding prosperity, we cannot afford complacency. Britain, he says, is no nearer a working arrangement with the European Common Market. The arrival of the American "compact" car and the removal of dollar restrictions may coincide to produce increasing American competition, particularly as the American "compacts" will be better suited to many of our export markets than the traditional American automobile.

With a consolidated profit before taxation of £1,902,046, the company is paying an increased dividend of 27 per cent.

GKN in Transistors

A new company, Floform Parts Limited, has been set up jointly by Guest Keen and Nettlefolds acting with Steel Industries, one of the leading makers of transistors in the United States. Floform Parts are expected to be producing high purity copper transistor bases for high capacity transistors by early 1960.

The new enterprise on the part of GKN represents a major break with a long tradition rooted in the manufacture of steel products. Mass production, however, is well understood by the company, who are one of the leading manufacturers of nuts and bolts in Europe, and they should be able therefore to take full advantage of American techniques. The parent companies will have equal representation on the board of Floform Parts and may continue to do so as they each hold 49 per cent of the capital.

Steel Agreement

The Wellman Smith Owen Engineering Corporation and the German company Vöest AG have concluded an agreement for exclusive cooperation in the United Kingdom in the design, supply and erection of plant and equipment for the LD-steelmaking process (one of the modern oxygen using methods).

Development of a Precision Dynamometer

A torque measuring instrument, using an air lubricated bearings and servo controlled electromagnetic torque balance, has been developed by the National Engineering Laboratory. With an accuracy of ±0.02 lb-in, it is believed to be considerably more sensitive than any commercially available instrument.

By M. Graneek, H. L. Wunsch and W. M. Nimmo

National Engineering Laboratory

With the present day high efficiencies of transmission units such as gearboxes, clutches, etc., the task of accurately determining their losses requires a very high precision, of the order of ± 0·1 per cent of the maximum value, in the measurement of input and output powers. The precise measurement of speed can be carried out satisfactorily with existing instruments, but since no torque-measuring equipment of the required accuracy was available commercially it was considered necessary to develop the precision dynamometer described in this report.

It consists of a driving and an absorbing unit with the power range indicated in Figs. 1a and 1b.

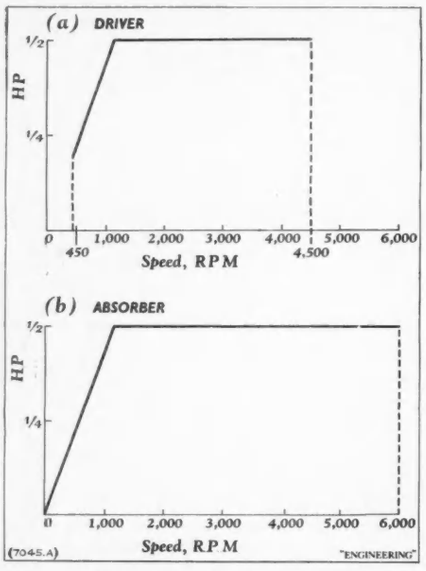
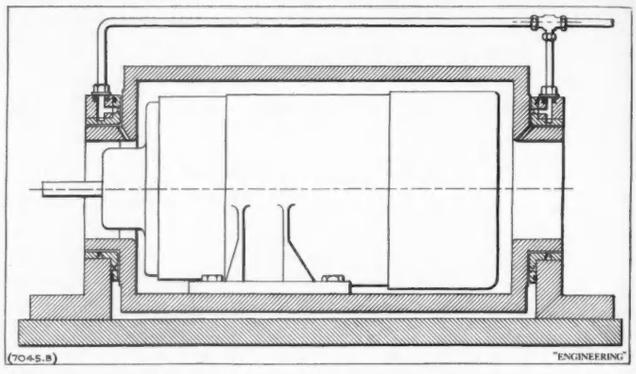


Fig. 1 (left) Power range.

Fig. 2 (right) Cross-section of driving unit trunnion mountings.



This range is determined partly by the electrical and mechanical design of the two units and partly by the fact that the maximum torque which can be measured on this equipment is 27 lb-in corresponding to 0·5 h.p. at 1,200 r.p.m.

In order to obtain the desired accuracy of torque measurement, the following features were incorporated in the design:—

(*a*) Both driving and absorbing units are mounted on air lubricated trunnion bearings having negligible friction.

(*b*) An electro-magnetic torque balance, controlled by a servo-system, is used for the measurement of torque.

Tests carried out on the dynamometer showed that torque can be measured to an accuracy of ± 0·02 lb-in; the measurement of speed is accurate to 0·1 r.p.m.

DESIGN

Driving Unit

The driver consists of a 0·5 h.p. three-phase electric induction motor, with a nominal speed of 1,450 r.p.m., coupled directly to a Kopp variable-speed unit to provide a continuously variable speed range of 3 to 1 both up and down from the motor speed at constant power. In this way the driving unit is capable of speeds from approximately 500 to 4,500 r.p.m.

The complete motor and variator assembly is mounted in a cradle as shown in Fig. 2, in cross section. The ends of the cradle are in the form of bearing journals, on which the whole unit is supported in two air-lubricated bearings, which are designed to provide both axial and radial location.

The journal bearings are 5 in diameter and 1 in long, and the thrust bearing consists of an annular ring of 1 in width. The radial clearance in the journal bearings is 0·001 in, and the air-admission orifices are 0·020 in in diameter with small pockets at their inner ends. Since the load on the bearings is always in a downward direction, the orifice distribution is made asymmetric, the five orifices in each bearing being spaced at 60° in the bottom part of the bush.

The thrust bearing has three orifices of 0·020 in diameter each, the orifices being connected by an annular groove, 0·125 in wide and about 0·005 in deep. The axial float of the unit is arranged to be about 0·008 in.

After assembly, the weight distribution of the floating unit was so arranged that the centre of gravity was as close as possible to the centre of rotation without actually making the unit unstable. In this way, the gravitational restoring torque on the unit for small angular deflections was kept very small. Tests carried out by placing small weights at a known distance from the centre of rotation showed that an applied torque of 0·002 lb-in was sufficient to produce a detectable movement in the unit. As this is rather less than 0·01 per cent of the designed full-scale torque of the dynamometer, it was considered quite satisfactory.

The two trunnion bearings are mounted on a plate which is also designed to take the torque and speed measuring units. In this way the driving unit can be moved as a completely independent part, as can be seen from Fig. 3, which is a view of both driving and absorbing units, together with a gearbox under tests.

Absorbing Unit

The absorbing unit consists of an electrical d.c. generator, generating at 200 V when driven at 2,000 r.p.m., and an integrally mounted Kopp variable-speed gear. In this way, by suitable adjustment of the Kopp variator, input speeds from 660 to 6,000 r.p.m. can be accommodated with the generator running at a constant speed of 2,000 r.p.m. At input speeds lower than 660 r.p.m., the generator will be running at less than 2,000 r.p.m. and will therefore be generating at less than 200 V with a consequent loss of absorbed power. The output from the generator is coupled to a constant external load resistance, the total resistance in the armature circuit being 100 ohms. The electrical power absorption at a generator speed of 2,000 r.p.m. is approximately 0·5 h.p. (i.e. 200 V through 100 ohms). The absorbed load can be varied by changing the generator field voltage; this is done by means of a Variac transformer and rectifier, which together give a d.c. output varying from 0 to 200 V. At zero field voltage there will still be a small residual load due to remanent magnetism in the field coils and mechanical losses in the absorber. If it is required to decrease the absorbed load to zero the circuit has been so arranged that, by applying a small voltage to the armature, the generator can be "motored" in either direction to nullify the effects of mechanical losses. In addition, this ability to "motor" is used when adjusting the zero balance of the unit, as described in a later section.

As before, air lubricated bearings of a conventional design were used; in this case the bearings are each 2½ in diameter by 1 in long, their design being similar to that described for the driving unit. The smaller size is accounted for by the fact that the absorbing unit is considerably lighter than the driving unit with its cradle.

As in the case of the driving unit, the weight distribution of the floating unit was adjusted after assembly to bring the centre of gravity near to the centre of rotation. Tests showed that the sensitivity to small torque changes was satisfactory.

The unit is mounted on a plate similar to the one used for the driving unit (Fig. 3).

TORQUE MEASUREMENT

In order to determine the output and input powers of a transmission unit ahd hence, its efficiency under various load conditions, it is necessary to measure both the torque and speed at the input and output shafts. The most convenient, and accurate, way of determining the torque exerted by the output shaft of the driving unit (or that exerted on the input shaft of the absorbing unit) is to measure the torque rection on the casing of the unit, since this will in all cases be equal and opposite to the required value, regardless of any variations in internal conditions (e.g., bearing friction) of the motor or generator. This can be achieved by mounting the complete unit on supports which are as nearly frictionless as possible and which allow it to swing freely. It was for this reason that the air trunnion bearings, described in a previous section, were incorporated, since these form the nearest possible approach to the required frictionless state.

The measurement of the torque reaction on both driving and absorbing units is carried out electromagnetically, the system being shown schematically in Fig. 5.

A torque arm is attached to the casing of the motor or generator and carries at its other end an aluminium coil former which has two coils, each of 25 turns of insulated copper wire, wound on it. The coils are so positioned that

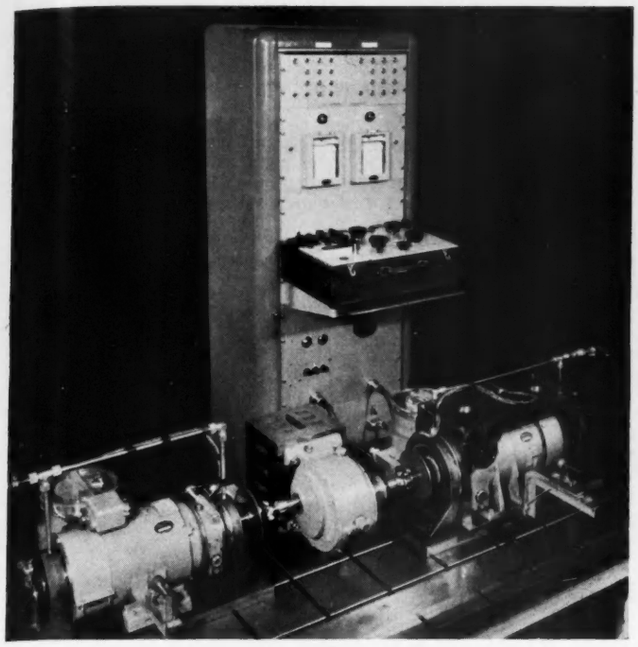


Fig. 3 (left) Dynamometer with gearbox under test.

Fig. 4 (above) Detail arrangement of driving unit.

rotation of the unit through a small angle in its trunnion bearings causes them to move in the permanent magnetic field of a pot magnet. The permanent magnet material used is Alcomax III, chosen for its high magnetic energy and stability

One of the coils, referred to as the "main coil," is supplied with a steady but adjustable current which can be measured to a high degree of accuracy on a d.c. potentiometer. The maximum current carried by this coil is sufficient to balance out the full-scale torque of 27 lb-in, for which the dynamometer is designed,

The second coil, referred to as the "servo coil," carries a variable current controlled by a servo system operated, as described below, by the small rotational movements of the motor or generator unit on its trunnions. This current has a maximum value of about 1·5 per cent of the maximum main coil current and is recorded on a conventional pen recorder using a centre zero. While this type of recorder may only be accurate to 2 per cent of its full-scale reading, it will not matter in this case where it is only recording 1·5 per cent of the full-scale dynamometer torque. In other words, the accuracy of the measurements taken on the recorder referred to the full-scale dynamometer torque, will be 2 per cent of 1·5 per cent, or about 0·03 per cent, which is well within the required accuracy.

The total torque will, therefore, be the algebraic sum of that exerted by the main coil and that of the servo coil. A view of the coil, and magnet, can be seen in Fig. 4.

Main Torque Coil

The current in the main torque coil, which was arranged to be about 1·5 amp maximum, is supplied from a 12V battery in order to avoid any possibility of a.c. ripple or mains voltage variation. Its magnitude is controlled by a conductance box, the smallest increment of current being about 1 mA. A reversing switch suitably placed in the circuit enables current to be passed through the coil in either direction to allow for both directions of rotation of the unit. A 1 ohm shunt, having low temperature sensitivity and high stability, is included in the circuit and the potential drop across it, measured on a precision d.c. potentiometer, directly indicates the current flowing in the coil. The arrangement of this circuit, and the servo-coil circuit mentioned below, is shown in Fig. 5.

Servo Coil

The current in the servo coil is controlled by a photocell positional pick-up (shown in Fig. 4) consisting of a light source and photocell fixed to the base plate of the machine, and a metal vane attached to the swinging unit. This vane is arranged to cut off the light from the photocell progressively as the unit rotates on its trunnions, thus causing the photocell to give a variable output signal. This signal is amplified in a transistor amplifier and fed back through the servo coil and a 20 mA chart recorder connected in series. The whole system, therefore, forms a closed loop and there is always just sufficient current flowing in the servo coil to balance out the residual torque reaction, providing this residual corresponds to a current of less than $\pm$ 10 mA, i.e., providing the recorder pen remains on scale. The chart reading, suitably converted into torque by means of the calibration factor, is therefore added to or subtracted from the main torque reading to give the total torque reaction on the unit.

SPEED MEASUREMENT

Speed measurement is carried out on each unit by means of a photo-electric pick-up. A disc having 60 holes around its circumference is attached to the shaft of each unit. A focused light source is arranged to shine through these holes during rotation of the discs and the transmitted light is picked up on a germanium photocell. The resulting pulses are counted on a frequency monitor or frequency meter. Using a frequency monitor and counting over a time interval of 10 sec, the speed is given directly in revolutions per minute to an accuracy of 0·1 r.p.m.

The speed-measuring system can be seen in Fig. 4.

CALIBRATION

For the purpose of calibrating the torque coils of the dynamometer, it is necessary to be able to apply a known torque to the unit by means of dead weights. For this purpose, second arms are fitted to both the motor and absorber units on the sides opposite to the coil arms. Each arm carries a vee notch capable of supporting a knife edge and scale pan (Fig. 4). The distance from this vee notch to the centre of the trunnion bearing was measured to an accuracy of at least 0·002 in over an arm length of 12 in. The weights used for the calibration were checked and found to be accurate to 0·1 mg.

The actual torque calibration of each unit was carried out in two parts. For the calibration of the servo coil, the main coil was left on open circuit. With the scale pan suspended from the knife edge, the unit was mechanically balanced to bring the pen of the chart recorder to the edge of the paper. Small increments of weight were then added to the scale pan and the recorder pen movements were noted for both increasing and decreasing weights. In this way, it was found that on both units one chart division was equal to 0·01 lb-in of torque. Full-scale deflec-

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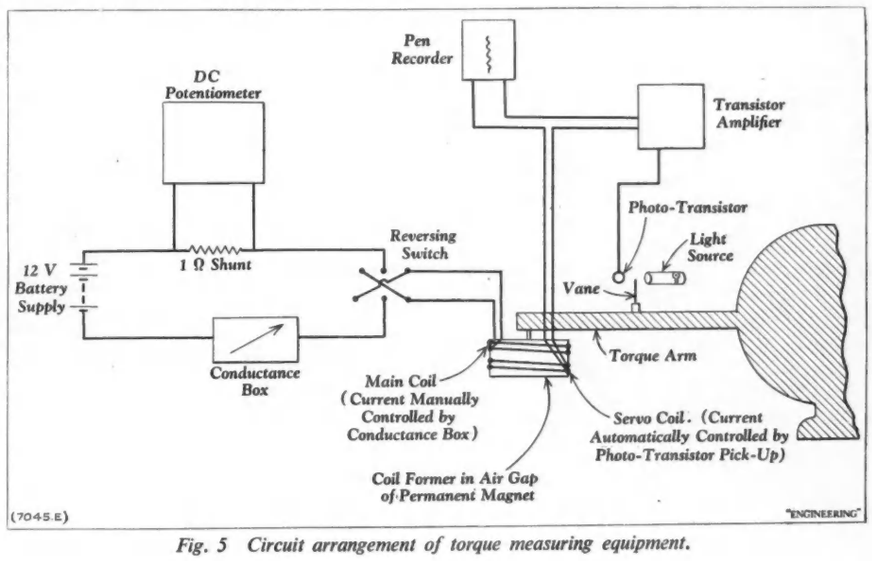


Fig. 5 Circuit arrangement of torque measuring equipment.

The Workshop Behind the Back Room

Set in pleasant, semi-rural surroundings at Cross Oak Lane, Salfords, Surrey, the Mullard Research Laboratories employ some 750 people, most of whom are graduates of universities or professional institutions. Roughly one-third of the establishment's personnel are employed in the engineering division (which is mostly concerned with mechanical engineering), although the subjects of their research are entirely outside the field of mechanical engineering: semiconductors, television, radar, special valves, microwave devices and vacuum physics.

This is not a case of mismanagement, nor of highly successful empire building—on the contrary it would appear to reflect a decidedly enlightened management policy if judgment can be made on the basis of the establishment's success in research. True it is seldom possible to assess the value of pure research in terms of tangible end-products, but its efficacy can, to some extent, be judged by the undoubted success of the parent company. In addition to this, the MRL have produced a number of laboratory-made items which have been successful on the commercial market. For instance, they were responsible for the design and development of a 4 MeV particle accelerator which recently became the first British machine of its type to be sold to the Russians. Image converters which can be used to intensify non-visible images or to obtain photographic exposures of 10^{-8} seconds duration, are further examples of the MRL's saleable end-products.

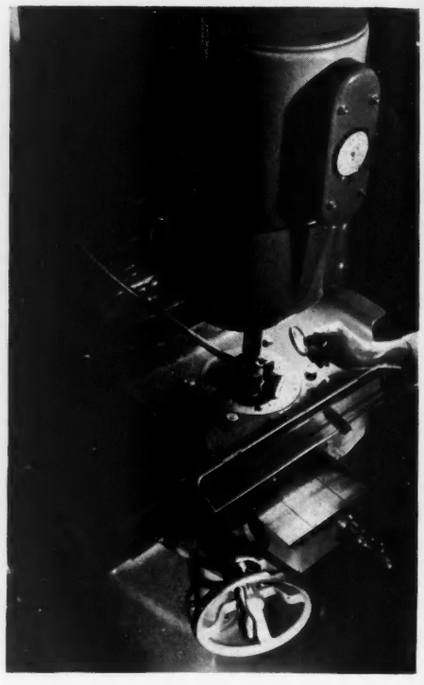
So it would appear that the success of this laboratory, and of its parent company, is testimony to the importance of good mechanical (and allied) engineering facilities to research into non-mechanical phenomena. In other words, the all too popular idea that the research worker is at his best when forced to improvise is not applied at Mullards, at least not in terms of engineering workshop facilities.

In addition to the full recognition of the importance of engineering services, further enlightened understanding was shown recently when the engineering division at Salfords put on an internal exhibition of their work. The sole object of this was to overcome the very real difficulty of effecting close liaison between research worker and engineer.

All too often the research worker with no practical experience of mechanical engineering techniques demands the impossible from his engineering colleagues and then, after several similarly frustrating encounters, often gives up. This is disastrous in the long run, and must be avoided. Not so obviously undesirable, however, is the less extreme but very much more common case of the research worker who does not fully understand the capabilities of the engineering services at his disposal. This state of affairs will not lead to any drastic breakdowns but it does mean that maximum effectiveness can never be achieved. An internal exhibition is not always practicable, nor is it the only means of liaison, but it is undoubtedly worth the trouble even when the pressure of work is as high as it is at Mullards.

Preparing to evaporate a metallised film for an image converter tube—cleanliness is essential.

Inspecting the profile of a tungsten carbide gauge, machined on a high power ultrasonic drill.



Concluding Development of a Precision Dynamometer

tion of the recorder corresponds to 0·4 lb-in, which is 1·5 per cent of the full-scale torque (27 lb-in) of the dynamometer.

To calibrate the main torque coil, the servo-coil circuit was used merely as a fiducial indicator. The unit was mechanically balanced to bring the recorder pen accurately to the centre of the paper. Increments of weight (in steps of 200 *g*) were then added to the scale pan, and for each increment the recorder pen was brought back to the centre of the paper by energising the main coil, the current being adjusted by means of the conductance box and measured on the d.c. potentiometer. This calibration was continued up to a torque corresponding to full-scale torque of the dynamometer, i.e., about 27 lb-in, readings being taken for both increasing and decreasing values of torque. In order to obtain the best possible accuracy of calibration a mean line was drawn through these results by the method of least squares, thus giving a value of torque per unit current in the main coil.

Both the servo-coil and main-coil calibrations were carried out with the motor and generator at rest and also running at 1,500 r.p.m. No difference in calibration could be detected between the running and stationary conditions.

Each main-coil calibration figure given is the mean of results from at least five and, in some cases, ten separate tests. All these results lie within 0·05 per cent of this mean, the majority being within 0·03 per cent.

INITIAL BALANCING

Before commencing any torque measurements on either unit it is, of course, necessary to balance the unit mechanically by means of weights on the load arms (Fig. 4). For convenience it was decided to use the servo current recorder with a central datum, so that readings on it are either subtracted from or added to the main-coil torque according to their position relative to the centre of the chart. To achieve initial balance, therefore, it is only necessary to adjust the weights until the recorder pen is on the chart centre with no current flowing in the main coil.

Mainly because of the presence of oil in the Kopp variable-speed gear, it was found that the balance of each unit varied according to whether the motor or generator was at rest or rotating and, moreover, depended on the direction and speed of rotation. For this reason it was found to be necessary to carry out the initial balancing of both units under the conditions applying during the subsequent tests, i.e., running at the same speed in the same direction. This was fairly simple on the driving unit, but it was necessary to be able to motor the absorbing unit at any speed within its normal range. This was done by providing controls for putting full field voltage and variable armature voltage on the absorber, the armature voltage being reversible in order to obtain either direction of the rotation. The same Variac transformer and rectifier are used to provide both the variable armature voltage for this purpose and the variable field voltage when the absorber is in normal use.

In this way it was possible to balance each unit independently while running at its correct speed in the correct direction. In addition to compensating for the effects of oil swirl in the Kopp variator, this method of balancing also cancelled out any effect of external windage on the coupling, speed-measuring disc, and so on.

PERFORMANCE TESTS

To check the overall performance of both units, including all calibration values, the two units were first of all individually balanced while each was running at the test speed. They were then coupled together, using a suitable flexible coupling. Under these circumstances, when the driving unit is allowed to drive the absorbing unit, the torque readings on the two units should be exactly the same, since there cannot be any external losses. Any difference in torque, therefore, will give a measure of the overall accuracy of the dynamometer.

Tests were carried out at speeds of 700, 1,500, 3,000 and 4,500 r.p.m. in both directions of rotation and at torque loads varying from zero to maximum, approximately 27 lb-in. These showed that the dynamometer errors are always less than $\pm$ 0·02 lb-in, and are largely of a random nature unrelated to the magnitude of the load.

Acknowledgements

The authors wish to acknowledge the assistance rendered by their colleague Mr. T. W. Aitchison in the design of the servo amplifiers.

The work described has been carried out in the Mechanisms, Metrology and Noise Control Division of the National Engineering Laboratory and this paper is published by permission of the Director.

On the Shelf

By Frank H. Smith

A small item in the current *The Indexer* (Society of Indexers, 15 Avenue House, Allitsen Road, London, NW8) is called " On the Rocks " and describes how the writer brings back from each seaside trip interesting rocks, fossils and what-have-you to mark places in open books, keep index cards apart and so on. There's absolutely no limit to the vistas that this hobby-adaptation opens. I'm a cyclist myself (as I've said before) and I can think of similar ways of using old inner tubes, covers, tandem frames and the rest. (As a matter of fact, darned good rubber bands *can* be cut from old inner tubes. In one instance I excluded all the light from my son's box camera with one.)

HM Stationery Office will get for you USGPO publication LC26.9:Z/959, which is Library of Congress *Classification Class Z, Bibliography and Library Science*, 4th edition, 1959, 226 pages at $1·75. Also of interest and from the same list is LC1.2:R24/2, *Preservation and Storage of Sound Recordings*.

The *ARS Journal* (American Rocket Society, 500 Fifth Avenue, New York 36) for October (No. 10, Part 1) contains a new departure in the form of 47 buff pages forming a Russian supplement. This contains translations of ten papers likely to be of interest to the society's members. The same number also gives a review article that is entitled " Recent Advances in Space Propulsion " and which has a classified bibliography of 150 items.

Foreigners do these things so much better than we. When I opened my copy of *Der Flieger* the other day an insert fell out. It was not a postcard for subscriptions to a book club, for a kids' encyclopaedia, for a subscription to another journal in the group. It was an invitation to buy bottles of Finkenauer, feiner Riesling—ein Sekt aus reinen Rieslingtrauben unseres Kreuznacher Gutes. Which, freely translated, means a sack—of the clear Riesling bunches of our Kreuznach estate.

Luckily, Russian does not change much from day to day, because I am a bit late with the British Iron and Steel Federation's neat little dictionary (Eng.-Russ.; Russ.-Eng.) devoted to continuous casting. It has a little more than a mere dictionary (for instance diagrams of the processes and a map of the plants in the Union) and what is more it is free to bona fide inquirers. Apply to the Information Officer, British Iron and Steel Federation, Steel House, Tothill Street, London, SW1, and you can mention where you saw it if you like—there's no commission.

An undated circular tells me that " early next month " some of the Pergamon setup will be moving to Headington Hill Hall, Oxford. In the course of the circular one is told that Pergamon and its associates is the nearest Western equivalent to the " mammoth Institute of Scientific Information run by the USSR Academy of Sciences in Moscow, which is credited with giving Soviet scientists such an advantage over their Western opposite numbers." When one considers that this is largely the effort of one man, one has to compliment Captain Maxwell on his efforts to counteract the Russian advantage.

Imperial College (of Science and Technology of course) of Prince Consort Road, London, SW7, have issued their prospectus for 1960-61. There are photographic illustrations on four pages and I wonder what is the qualification for such photographs. One can understand a picture of the model of the finished college, an artist's impression of the facade of Weeks Hall and, possibly, the supersonic wind tunnel, but what on earth is the point of " Botany in Winter (the Royal Albert Hall in the background). Tobacco plants for experiments get sixteen hours of ' daylight ' all through the year." There I go again—ignorant as they make 'em.

ALMOST HUMAN BUT NOT QUITE

Multivibrator Circuits. By A. H. BRUINSMA. *Cleaver-Hume Press.* (9*s* 6*d*)

Practical Robot Circuits. By A. H. BRUINSMA. *Cleaver-Hume Press.* (17*s* 6*d*)

Symbolic Logic and Intelligent Machines. By EDMUND C. BERKELEY. *Chapman and Hall.* (52*s*)

rom time to time the popular press reports that a new " robot " or " electronic brain " has made its appearance and that, in consequence, either the millenium is at hand or alternatively the end of the human race is in sight. The non-specialist may be puzzled by such pronouncements but, at the same time, be interested to know the precise basis which underlies the design and capabilities of such automata.

Mechanical automata are of great antiquity and range from the oracles of ancient Greece to the androides of Albertus Magnus and thence, via the chess-player of Kempelen, to the " tortoise " of Grey Walter.

In general terms the way in which the most recent thinking in the field of robot construction differs from that which applied in the past is that today two different types of robot device are recognised. The first type is that in which the machine duplicates some animal or human attribute of a more or less deterministic kind, for example, in guiding a ship or aircraft or in playing a simple game such as " noughts and crosses." The second type of machine seeks to duplicate the more random aspects of living matter and, in particular, attempts to simulate the processes of thought which are often stated to distinguish man from his primitive ancestors. Some at least of these topics are covered in the three books under review, but a truly comprehensive and definitive work on the subject is still needed.

Bruinsma, in his book on multivibrator circuits, examines some purely electronic problems which occur in the design of circuits which have several boundary states in which they may either be stable or between which they may oscillate. The book is very clearly written and describes, without elaborate mathematics, the way in which oscillation or stability is produced and how the various times which are involved can be calculated. These topics occupy the first 56 pages of the book, and the remaining nine pages ramble happily, if superficially, through the problem of " gates," that is, devices which permit or prevent the passage of electronic signals from one part of a circuit to another. The only real criticism of the book is the absence of detailed component values which would have given the circuits more appeal in the eyes of the experimentally minded amateur. It is only fair to state, however, that Bruinsma mentions specifically that the book is really only a theoretical " appendix " to his book on practical robot circuits.

The latter book attempts to do three things: first, to discuss the way in which sight, hearing, touch and memory may be simulated in a form which is suitable for inclusion in a small artificial animal; second, to show how such an animal, with about the size and complexity of a dog, can be built; and third, to discuss the construction of a machine for playing " noughts and crosses." In the first two of these objectives the author is wholly successful and he provides a useful basic stock of parts from which other small robots could be constructed. The noughts and crosses player, on the other hand, seems unnecessarily complex. It would be expensive to build and is inferior to the machines constructed in this country by Davis and by Tocher. Nevertheless, readers who are unfamiliar with the way in which games can be played by means of electrical circuits will find the description instructive.

Both of Bruinsma's books have been translated from the original German by E. Harker, who is to be congratulated for the smoothness of the results. Even without considering the low price both books can be thoroughly recommended.

Berkeley's book on symbolic logic and intelligent machines is the third which he has produced in this general field. He is already well known as a popular expositor of digital computer technology and as the editor of the magazine *Computers and Automation*. The present book contains two distinct themes, the first a popular approach to Boolean algebra and symbolic logic, the second an application of these disciplines to the solution of various problems in logical analysis, arithmetical circuit design for computers, and the design of simple " animals."

The sections on symbolic logic are well written and amply illustrated by means of amusing examples such as " No employees are both male and female." The reviewer does not perhaps have quite the author's enthusiasm for symbolic logic as a design tool, but this is a personal opinion which is not shared by all engineers. Another personal note is sounded when Berkeley states in his preface that he found Boole's *Laws of Thought* confusing. This is the opposite of the experience of the reviewer, who found it so fascinating that he read it through in a single sitting (8 p.m. to 10 a.m.!).

The section on problems and problem solving confines itself to such things as hall light switches for three floors and " Bruce Campbell's Will," and these topics are followed by a discussion of the logical design of adding, subtracting and multiplying circuits for a computing machine. These topics lead into symbolic logic and thence to a discussion of signalling and of " the divorce mill with bigamy alarm."

Finally there is an account of the logical desiderata of a small robot animal, " Squee "—the squirrel—which can hunt, home, or deposit. No technical details are given, however, so that, from the point of view of practical robot construction, the reader must look elsewhere.

Almost as a *non sequitur* the book ends with a chapter on computer programming and an example of a programme for the extraction of a square root. There is also a good bibliography of the field of logic as applied to computing.

As an elementary introduction to the logical theory behind computer design this book can be strongly recommended; for those who merely wish to know how to make a robot for themselves, however, the Bruinsma books supply the answer without pain.

ANDREW D. BOOTH

TERMS OF EMPLOYMENT

Glory Without Power. By RICHARD CLEMENTS. *Arthur Barker.* (11*s* 6*d*)

Trade Union Law. 6th edition. By H. SAMUELS. *Stevens.* (17*s* 6*d*)

Many people in the engineering industry, whether managing directors, works managers, or personnel managers, spend a great part of their time dealing with trade union problems, and to such people books on the subject of trade unions are of more than passing interest.

However, it is important for these executives to realise that quite apart from those trade union activities which impinge directly on their own business, there are aspects of the trade union movement divorced from the day to day problems of the shop floor. Two recent publications concerned with some of these aspects are of interest to students of trade union matters, but they are unlikely to interest those whose contacts with the trade unions occur only across the negotiating table.

Mr. Samuels is a barrister-at-law who has

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XUM

been remarkably successful in his *Trade Union Law* in summarising the main facts of this very complex subject in 100 pages, taking his readers from the Statute of Labourers of 1349 to the Terms and Conditions of Employment Act of 1959. This book explains the unique legal position of trade unions (which for legal purposes includes some trade associations also) as combinations of individuals with limited corporate identity.

The law, however, is principally concerned with the relation of trade unions with their members, with the public and with the authorities and hardly at all with relations between employees and employers. Unlike many other countries collective industrial agreements in Britain do not have the force of law and are rather in the nature of gentlemen's agreements and so they very largely lie outside the scope of Mr. Samuel's text. Whereas this book should find its place on the shelves of every branch secretary and of solicitors practising in industrial towns, it is unlikely to be needed much by the busy engineering employer, though it is useful background for the prospective personnel manager.

The other new book which deals with trade unions is *Glory Without Power*, by Mr. Richard Clements, but although this is interesting and well written it is really a political pamphlet which has been artificially expanded to book size. Mr. Clements' concern is with the declining influence of the trade unions in British society and there is no denying that this is a very real problem for the trade unions. It is hard to realise that only 10 years ago a delegate to the Conservative Party Conference could always raise a resounding cheer from the retired Colonels and county housewives there by describing himself as a trade unionist whereas early this year the assistant secretary of the TUC came to the BBC microphones to try to explain the unpopularity of the trade union movement and many commentators are wondering how far the Labour Party's defeat in the 1959 General Election was caused by its association with the trade unions.

Mr. Richard Clements believes passionately in the trade union and labour movements and puts forward a programme for their reform and no doubt hopes to convert other members of the movement to these beliefs.

The most valuable part of the book is where Mr. Clements puts the present troubles in historical perspective. During the period from 1798 to 1834 the trade unions grew in strength and then collapsed after the disaster of the Tolpuddle martyrs, remaining quiescent until 1850. The second phase which began then culminated in the General Strike in 1926 when once again trade unionism suffered a defeat that lasted for several years. During and immediately after the Second World War their power and influence rose again and during the late 1940's and early 1950's it was customary to think of the trade unions as an estate of the realm. Mr. Clements rightly says that the present difficulties arise from a clash of policy between the trade unions and the Government over wages which culminated in the 1958 bus strike.

Mr. Clements wants the trade unions to use their political power to obtain industrial ends and his historical sketch is marred by a confusion between political and industrial purposes. At no point does the author see that his solution is contrary to the whole of British history of which the only constant feature has been the defeat of any sectional influence that has tried to dominate the rest of society for more than a limited time.

The whole basis of our modern industrial society is its variety. Firms, companies, managements, individual engineers, are all seeking their own particular interests and from the interweaving and inter-reaction of these individual interests springs the whole complex of our modern economy. Within this fabric the trade unions have a vital role to play as a balancing factor but to try, as Mr. Clements does, to imbue trade unions with some sort of moral purpose that involves the shaping of society for the benefit of their members is to lead them along a dangerous road.

It would be unthinkable to suggest that individual firms and companies should set aside their business interests in order to advance a particular political philosophy and yet it is still argued that the trade unions should turn aside from their vital day to day activities to chase some such will-o'-the-wisp. It is to be hoped that wiser counsels in the trade union movement will prevail over Mr. Clements' advice.

K. A. LANE

SERVO RESPONSE

Principles of Automatic Controls. By FLOYD E. NIXON. *Macmillan.* (30*s*)

Recent additions to the growing library of works on automatic control systems have ranged from the most advanced mathematical treatise to introductions for the layman. This volume takes an admirable middle course. To quote from the author's own preface: " The basic aim of this book is to give the reader a reasonably complete understanding of the various principles utilised in the design of an automatic control system."

The present book covers, with an easy style, a very wide field and it cannot, therefore, be expected to include the detail on particular subjects that the practising servo-engineer would demand from a reference work. But it could serve to orient his thinking in relation to the ever growing field of automatic control. To the student or young graduate this book would be an easily digested work for private study and because of the fluent and interesting way in which it is written it is above average for this purpose. Because it is so well suited to independent study it is particularly unfortunate that the problems set at the end of each chapter are not provided with answers.

The book opens with a review of mathematics, including the Laplace transform, and shows how they are applied to control system analysis. As usual in the more elementary works, the techniques of integration leading to the inverse Laplace transform are not discussed. Instead a very comprehensive taole of transform pairs is given, allowing the Laplace transform to be used as a tool similar to logarithms. Chapters on block diagram notation, analysing the open loop function, and types of compensation are particularly well written. The chapter on numerical analysis and Runge-Kutta methods is an extremely lucid introduction to this technique for obtaining information on system performance, especially if the servo is of high order or non-linear.

The book concludes with a useful general survey of computers for control system analysis and a chapter on transient response. The final chapter on non-linear systems is probably too short to be of much use. The index is adequate, but the bibliography of 50 items is somewhat limited, although it does include many of the classical books and papers on control system techniques, including the father of them all *Directional Stability of Automatically Steered Bodies* by Minorsky.

The author is an American and the book was originally published in 1957 by Prentice-Hall of the United States, it might be because of the author's nationality that the approach of Brown and Campbell's *Principles of Servo Mechanisms* seems to run through some of the pages. The book can be recommended as a good introductory text for the student and as refreshing reading for the practising engineer. The publishers must be commended for presenting a book of this magnitude at a price of thirty shillings.

MICHAEL JAMES

The Reviewers

Dr. A. D. Booth is head of the Department of Numerical Automation at Birkbeck College, University of London. He is a D.Sc., a Ph.D. and a B.Sc., in physics and mathematics, a fellow of the Institute of Physics and a member of the British Institution of Radio Engineers.

Mr. K. A. Lane is a physicist by training but has been concerned during the later part of his career with general business management. He was at one time personnel manager in a rubber factory in South Wales and subsequently in charge of administration and personnel at one of the English Electric Company's factories. He is now at the headquarters of the same company. He is a Cambridge MA.

Mr. Michael James has been concerned over the past 10 years with system analysis and engineering design of advanced servo-mechanisms and electronic devices with particular reference to guided weapons. He has been responsible for a series of post-graduate lectures on servo-mechanisms and is a member of the technical committee of the British Institution of Radio Engineers. He is also a member of the Society of Instrument Technology and holds an honours diploma in electronics. He has recently taken responsibility for a system analysis and electronic engineering department set up by de Havilland Propellers Limited to study the application of automation in industry.

NEW BOOKS

Lloyd's Register of Shipping, Register Book 1959-60: Volume I, Register of Ships; Volume II, Appendix; Volume III, Shipowners. *Lloyd's Register of Shipping.* (*Volume I*: 360*s*; *Volume II*: 80*s*; *Volume III*: 60*s*)

It is sufficient to say that these three volumes are now available. The contents will be well enough known. The *Directory* (Volume IV) will be published in January, 1960.

Workshop Technology, Part I. 3rd Edition. By W. A. J. CHAPMAN. *Edward Arnold (Publishers) Limited, London.* (15*s*)

Dr. Chapman, Principal of Hatfield Technical College, has written this introductory course bearing in mind both the craftsman in the workshop, and the designer and engineer needing a clear background knowledge.

Properties of Matter. 3rd Edition. By F. C. CHAMPION and N. DAVY. *Blackie and Son Limited.* (40*s*)

First published in 1936, the important change in this edition is . . . the gradual orientation of the subject from a largely phenomenological treatment to atomic interpretations. The authors acknowledge over 20 sources for diagrams and plates.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Equipment

Mobile Platforms. HENRY SIMON LTD., Cheadle Heath, Stockport. Hydraulically-operated working platforms for maintenance and repair work. Lorry mounted for heights up to 48 ft. Illustrated brochure.

Swarf Baler. PORTABLE BALERS LTD., Hudson's Drive, Cotteridge, Birmingham 30. Portable balers for swarf and scrap. Leaflet.

Chain Saw. J. CLUBLEY ARMSTRONG DANARM LTD., Abford House, Wilton Road, London, SW1. Mark II version of the Danarm R8F petrol driven chain saw. Cuts up to 4 ft diameter trees. Leaflet.

Drafting Machine. DARGUE BROTHERS LTD., Simplon Works, Halifax. The Speedrafter with parallel motion and drafting head. Several models. Illustrated folder.

Dictating Machine. E. SHIPTON & CO. LTD., 181 Queen Victoria Street, London, EC4. The Interecorder magnetic tape dictating machine with cassette loading and remote control. Leaflet.

No Rust with Standard Antifreezes

Antifreeze mixtures are not new, but work performed in the last ten years on methods of inhibiting corrosion has been required to assure their real value. Now, three individual inhibitor systems have been standardised for use with the most popular antifreeze mixture in this country —ethylene glycol and water. British Standard numbers for these are 3150/1/2 : 1959.

Before briefly considering what inhibitor is best for what system it is worth looking at alternative mixtures—is any other ideal? Well, certainly there are other additives, basically the alcohols, methyl, ethyl and isopropyl. The first of these is widely used in the United States, but shares two common characteristics with the alcohols in the form of high volatility and low flash point. Neither of these properties is desirable. The glycols, among which propylene and diethyl glycol could be used in place of monoethylene glycol, have the reverse properties of high boiling and flash points. With them, however, comes corrosion.

Unfortunately no inexpensive chemical is ideal—hence the making best of a bad job by adding inhibitors to a glycol/water antifreeze. The amount of monoethylene glycol made in this country by Shell Chemicals and ICI—soon to be joined by Union Carbide—already runs into tens of thousands of tons annually, and most goes into antifreezes. Once with the water, this chemical affords good protection: with a 20 per cent mixture the first ice crystals appear at 10° F, with 33 per cent, at − 3° F, and with 50 per cent, at − 33° F. Above 60 per cent, incidentally, the melting point rises again with no benefit.

The first glycol antifreezes were developed for the aircraft industry prior to the First World War, and depended almost entirely on inhibition of corrosion by a mixture of sodium mercaptobenzothiazole and triethanolammonium orthophosphate. This was soon given the Ministry of Supply specification DTD 779, and remained virtually unchallenged in use, until about ten years ago. With aluminium and non-ferrous alloys this inhibitor was, and still is, very effective, but trouble was encountered with ferrous alloys in the system; no good, one would think therefore for cars. It was, however, used in car antifreezes—and trouble was encountered; this was most poignant with diesel engines, where hot spots and leakage of sulphurous fumes from gaskets into coolant caused acidity and rapid lowering of the pH value.

Some years ago the part of DSIR now known as the National Chemical Laboratory established a formulation based on an addition of about 5 per cent sodium nitrite and sodium benzoate used in a ratio greater than 9 : 1. This proved suitable for rentention throughout the summer, even without the glycol added, to give continuous protection. This inhibitor, as named in the second British Standard, can be used generally in domestic vehicles. While the nitrite prevents attack on ferrous parts, the benzoate is busy preventing corrosion of solder by the nitrite.

Three systems of inhibiting antifreeze corrosion have been recognised in new British Standards.

The last system of inhibition is one which has come from America, and is straightforward sodium tetraborate. Borax, as this chemical is generally called, is inorganic and does not break down or oxidise. It brings with it a well-known buffering capacity and a reserve of alkalinity which allows it to cope with acid build-up. While recognised as safe for ferrous alloys, it is only presently being proven for light alloys. It might some time displace even the benzoate/nitrite inhibitor if this aspect can be satisfactorily solved.

Plastic/Metal Trim is More than Fanciful

It is just over two years since Howard Clayton-Wright started making a range of plastic/metal extrusions for use as trim. Although initially conceived as an embellishment strip for household products such as television sets and washing machines, its consumption was given a great boost when this company introduced it to the motor industry. Here it first displaced the rubber fillerstrip which is an integral part of the weatherstrips used for sealing; in so doing it added a metal surround which when used sensibly could be tastefully attractive. Then came the large move: with the modern approach to making bodywork replacement less expensive, there came the idea of leaving the spot welded panel flanges outside and visible. This, of course, demanded a strip of trim, and was the job which was given to one of the Claylastic sections. Other than use of a lens section on the Frisky made by Henry Meadows Limited, an embellishment strip on the BMC Austin 7 and Mini Minor marked the real beginning, a beginning which already consumes a weekly footage running into six figures.

On the BMC models one of the sections covers the raw edges from front wing to back wing as shown in the illustration. A different section can also be used for trimming cant rails.

Claylastic sections are extruded into a variety of shapes. They consist of bright aluminium foil completely shrouded by a thermoplastic material, cellulose acetate butyrate, which can itself be either transparent or opaque. Pigments can be added to the plastic so that when in the latter condition they could be made to blend in with the colour schemes of cars. Or they could, of course, be different colours. . . .

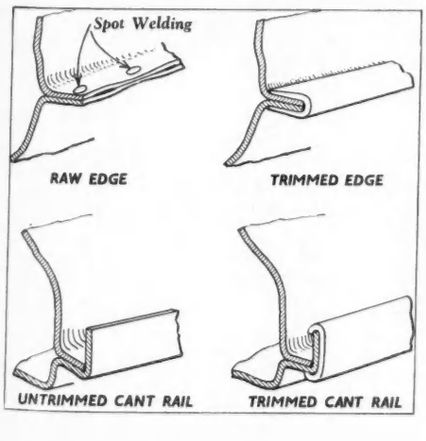
Cellulose acetate butyrate is made by reacting purified cellulose with acetic and butyric anhydrides in the presence of sulphuric acid as catalyst and glacial acetic acid as solvent. It was chosen as standard plastic for this application because it is very tough, is light, and has good outdoor weathering and ageing characteristics. In effect, this means that it is unaffected by the elements and, indeed, tests by Clayton Wright have proved it to be so, even in salty and other corrosive atmospheres. Where the plastic is used in the transparent form a high metallic lustre is attained, and this is manufactured in five standard finishes simulating chrome, brass, silver, copper and gold. To complete the deception, for it is not easy to tell that these sections are not solid metal, any surface scratches may be removed with chrome-cleaner.

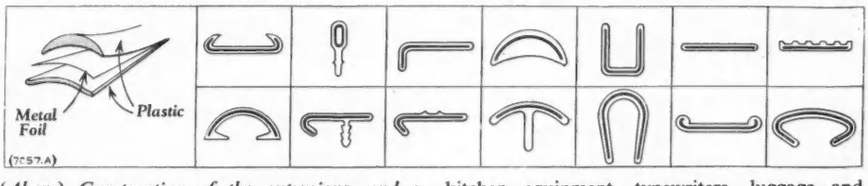
In the illustration are shown a selection of the sections currently made by this company. Each comes in a motley of sizes, but not many come from off-the-shelf. For more light hearted uses the aluminium foil can have a pattern—but there are no words to describe these. On furniture, Claylastic sections have been used, on kitchen equipment, typewriters, luggage and lamp-standards; anywhere, in fact, where embellishing or streamlining is required. For internal fittings on cars, they have found their way into trim for door panels and glove boxes, while there are now sections made in widths for facing instrument panels and door kick pads.

Strictly at the design stage, Claylastic is being considered for trim on buildings—well, petrol filling stations. Embellishment strips here might well be about 2 in wide and be applied to facias and display areas. The big advantage here is that they require no maintenance; the big disadvantage, that the colours can't be changed.

Techniques for fixing such trim number at least six, the two most popular in the automobile industry being use of adhesives or spring clips. BMC stick it on. At a slightly higher temperature of 90° C, the plastic becomes plastic and facilitates preforming.

Here then is the material. There is much that can be done with it, and certainly it will be interesting to see how far the idea catches on in the automobile industry, following the lead taken by the British Motor Corporation in using it on their new models.





(*Above*) *Construction of the extrusions, and a selection of the sections in which they come.*

(*Left*) *On the new BMC cars the long spot welded flanges are protected by a stuck on section.*

(*Below left*) *Details of what are probably the most useful sections for trim on car bodywork.*

Buses with Plastic Bonnets go to Chinese Green

Following the age-old adage, it is fitting that the ingenuity which went into designing the new LTE buses should manifest itself in the use of chinese green. Bakelite, who had a hand in this, say that more than hundred pieces of green decorative sheet used as trim around the interior of windows are from rigid pvc which is simple to fabricate and is " resistant to vandalism and chance damage." One might add " by dry rot or the death-watch beetle."

The use of plastics in these buses, however, is

There is good reason for using glass/polyester resin.

commendable. The distinctive curved bonnet top is in glass/polyester with colour incorporated, and is made by British Xylonite from Bakelite resins. This bonnet is a double-skin moulding of intricate shape.

Other reinforced plastics parts are the radiator surround with its integral number-plate housing, and the upper deck emergency door, which has a specified tolerance of only $\frac{1}{32}$ in on a width of 4 ft. The Routemasters are the first London Transport buses to contain a heating and ventilating system, taking air in through a grille below the front destination board. The lower ventilating trunk is once again of reinforced resin.

Heat Transfer Medium Stable up to 400° C

A new heat transfer medium has been added to the range of phenol derivatives by the Heavy Organic Chemicals Division of ICI at Billingham. Thermex, as it is called, is a 73·5 diphenyl oxide-26·5 diphenyl eutectic mixture. It is said to be the first heat transfer medium of this type to be manufactured commercially in Britain.

A desirable combination of physical properties makes Thermex suitable for liquid phase and vapour phase heating and cooling. It has a high boiling point of 255° C, and low freezing point of 12° C, and excellent thermal stability over long periods at temperatures up to 400° C. It has high heat transfer coefficients, particularly in the vapour phase; further, it is non-corrosive and presents a negligible fire risk.

At high temperatures, Thermex operates at low working pressures. For instance, at 250° C, when steam is at a gauge pressure of 565 lb per sq. in, Thermex is still in the liquid phase and at atmospheric pressure. At 350° C, the gauge pressure of steam is 2,385 lb per sq. in, while the comparable pressure of Thermex is only 80 lb per sq. in. Furthermore, in vapour phase heating, very accurate temperature control may be achieved simply by regulating the pressure. A single Thermex boiler may be used simultaneously for several different consuming points by adjusting the pressure at each point to give the desired temperature.

Typical examples of industrial processes in which Thermex can be used are the melting and spinning of synthetic fibres; the distillation and processing of fats, vegetable oils, petroleum fractions, and other high-boiling point products; the concentration of sulphuric acid and caustic soda solutions; the processing of plastics and rubber products by extrusion and moulding techniques; and the manufacture of paints and varnishes.

Find Flaws with Dye and Trichlor

At least one stage in the process of flaw detection with penetrant dyes will be made shorter by the introduction of Verimor—a penetrant ink marketed by Manchester Oil Refinery (Sales) Limited, 76 Jermyn Street, London, SW1. This ink can be removed with trichlorethylene vapour.

AID have approved use of the new dye, which can be used to best advantage on components which can be dipped into a degreasing bath, in other words, on small ones. A period of from 6-10 secs in the degreaser is sufficient to remove most surface dye after a penetration time of 10 mins. The component will dry immediately and can be developed straightaway with a spray developer such as Devmor (HF) made by the same firm.

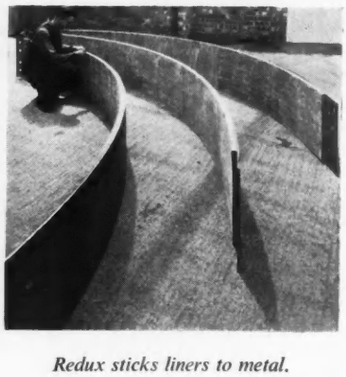
As with hot water washing, the longer the article is immersed for cleaning, the more dye is lost from the cracks—hence lower sensitivity. The maximum cleaning time is required for rough castings and is about 20 seconds.

Three other things are claimed for Verimor: because of its higher than usual flash point of 190° F it is safer to use in open tanks than water-washable dyes; it has less tendency to spread throughout the developer and clear delineation of cracks can be seen many hours after their first being obtained ; and that economy is achieved because gallons of pink water are not being run to waste—the vapour is clean even when the degreasing bath is contaminated.

Brake Liners Stuck in Place

These large brake liners, used by the National Coal Board for mine shaft lifting gear, are 13 ft long and 19 in wide. The 1 in thick sections of woven asbestos and cotton are bonded with Redux resin adhesive to the metal; four sections are required to cover the circumference of the braking wheel mechanism.

Redux is best known as an adhesive for metal aircraft structures but it is being increasingly used for bonding brake liners for industrial machinery as well as for motor vehicles.



Redux sticks liners to metal.

Mercedes-Benz and Citroen cars employ this adhesive for their brakes, and in this country several companies operating buses and taxicabs are taking advantage of the economies offered by the bonding technique.

Thixotropic Oil Makes Good Antirust

Report 242 of the Defence Standards Laboratories in Victoria, Australia, is rather grandly entitled " The Laboratory Development and Evaluation of a Thixotropic Protective Oil for Critical Metal Surfaces." What this really means is that by making an antirusting oil jellify, a thicker film can be maintained which is more protective—thin oil runs off.

Scientific chefs have long established a number of additives for oils which will cause thickening. These include aluminium stearate, amine-activated clays, mineral jellies, lanolin and microcrystalline waxes. All these the laboratories tried, the one with greatest success being a wax. The final formulation was based on an SAE 50 engine lubricating oil with corrosion preventive and acid neutralising additives, 2½ per cent microcrystalline wax (melting point about 190° F), and 1 per cent of a polyisobutylene of viscosity about 610 cS at 210° F. The average stable film thickness obtained was always at least 1·3 mg per sq. cm even after draining at 140° F for 14 weeks. This is 4 times the thickness of an untreated oil.

Such a protective composition may be used both internally or externally on engines and gearboxes and is dispersed by ordinary lubricants when the machine is put into use. It combines the protection of greases with the ease of application and removal of oils.

New Process for Upgrading Light Oils

A new Houdry process called Litol has been developed to upgrade the light aromatic fraction produced from coke ovens and similar processes. It is said to be considerably simpler than the competitive process which has been employed to a minor extent in America consisting of hydrofining, solvent extraction and distillation. Also it is thought to offer advantages on investment, operating expense and yield of benzene.

The light oil fraction, after removal of materials lighter than benzene and sulphur and heavier than C_9 aromatics, usually has an aromatic concentration in the order of 90 to 94 per cent. Older methods of purifying this material were a severe acid treatment with sulphuric acid, and then redistill into benzene, toluene, xylene and solvent naphtha cut. In spite of the drastic acid treatment, the final benzene produced contained too high a content of thiophene to be utilised in many of the chemical industries. The material thus produced was sold on a distress market since the quality was not competitive with that produced by solvent extraction of a reformate produced from catalytic reforming.

The new process makes a product which competes with that from extraction of petroleum fractions. It consists of passing a selected cut such as benzene—300° F boiling range fraction, at relatively high temperatures (1,100° F) and super-atmospheric pressure, over a Houdry catalyst. The non-aromatic materials which consist of the olefins, diolefins, naphthenes, thiophenes, etc., are completely destroyed to lighter hydrocarbons and hydrogen sulphide. In addition to the decomposition of the non-aromatic hydrocarbons, there occurs also demethylation of the heavier aromatics into benezene. The resulting product from the catalytic reactors is stabilised to remove all materials lighter than benzene, is then passed over a filter clay and followed by simple fractionation for the production of nitration grade benzene, toluene and 3° F xylenes.

Semi-conductor Rectifiers for Use on Ships

Semi-conductor rectifier equipment is used on HMS Mull of Kintyre for supplying other ships lying alongside with d.c. power from her 440 volt, 3 phase, 60 cycle main supply system.

During the last five years, many germanium rectifier outfits, ranging in size from a few kilowatts to over 18 megawatts, have been put in service for industrial, electro-chemical and traction duties. Now, Associated Electrical Industries Heavy Plant Division, Rugby, have produced what is believed to be the first large semi-conductor rectifier equipment for use on board ship, where the advantages of this static conversion equipment are particularly attractive. Two germanium rectifiers, each rated at 255 kW, 225 volts, 1,136 amp, were recently supplied to the Admiralty for installation in HMS Mull of Kintyre, a maintenance ship with a 440 volt, 3 phase, 60 cycle main supply system. The rectifiers will be used for providing d.c. power to other ships lying alongside.

Each rectifier is a self-contained unit complete with forced air cooled germanium rectifier cells, rectifier transformer, automatic voltage regulator, fan, air cooler, sea water pump, and all auxiliary relays, starters and fuses.

These components are housed in a steel-framed, aluminium alloy cubicle, the only external electrical connections being the main 440 volt, 3 phase a.c. input, the d.c. output and two remote warning circuits. Fig. 3 shows a unit with all the front covers removed, and in the left-hand cubicle section can be seen the rectifier cells mounted on trays, one of which is withdrawn from the cubicle for inspection. The centre-section contains the rectifier transformer, with the fan above it and the air cooler unit below it. The right-hand section houses the voltage regulator. All the auxiliary relays, starters and fuses are grouped together in the centre cubicle section, with access through hinged covers. The cubicles are built in three sections for ease of transport and installation, the three sections being bolted together when installed. The two 255 kW units face each other and the whole installation, including the space between the cubicles for withdrawing components, occupies about the space of an 11 ft cube.

All the equipment is built to Admiralty shock and vibration requirements, and there was no difficulty in adapting AEI standard industrial designs or rectifier trays (carrying solidly mounted germanium rectifier cells and their cooling fins) to meet these shock and vibration requirements.

The rectifier trays, three per unit, can be withdrawn from the cubicle to give access to the rectifier cells. Fig. 2 shows one in detail. The rectifier cells, type GPC, are connected in series and parallel in a 3 phase bridge connection.

Since the rectifier is to operate in ambient temperatures up to 50° C, closed air circuit cooling is used, the air being passed through an air-to-sea water heat exchanger in the lower part of the centre cubicle section. This air cooler, together with its water pump, pump motor and water flow failure alarm relay, form a compact unit which can be withdrawn on rollers from the cubicle for maintenance, as shown in Fig. 3. The direction of air flow is downwards through the centre cubicle section and upwards through the two outer sections. If there is any interruption in the cooling water supply, the rectifier can be changed over to open air circuit cooling, without taking the rectifier off load, by opening hinged covers at the end and front of the cubicle. In this condition (and with the fan running normally) the rectifier can be operated at its full rating if the ambient temperature does not exceed 35° C, or at reduced loads for ambient temperatures up to 50° C. There is no lower limit of air temperature when operating semi-conductor rectifiers.

The rectifier is required to give a d.c. output of 225 volts ± 2 per cent at any load and over the range of a.c. supply voltage fluctuations. This voltage control is obtained automatically by the use of a d.c. voltage relay, connected across the d.c. output terminals, which controls a pair of reversing contactors in the supply to the driving motor of the stepless voltage regulator. This regulator is a delta-connected auto-transformer with moving contacts. (See Fig. 1).

The output of the voltage regulator is connected to the primary of a buck and boost transformer, the secondary of which is connected in series with the secondary output of the main rectifier transformer, to raise or lower the a.c. voltage applied to the rectifier and consequently raise or lower the d.c. output voltage.

The rectifier is ready to be put on load immediately the 440 volt a.c. supply circuit-breaker is closed, for the fan and pump motors are connected to the same incoming supply. The overload rating of the rectifier is 25 per cent for 5 min or 100 per cent for 5 sec, and the overall efficiency at full load, calculated from a summation of losses including the power taken by the fan and the sea water pump, is 92·8 per cent.

The equipment described has several features, such as the need to meet Admiralty shock requirements and the inclusion of an air cooler and sea water pump within the cubicle, that would not often be required in a merchant ship. While closed air circuit cooling is always easily available in suitable cases, it should be noted that corrosion need not be a problem, for the rectifier cells are completely sealed and the protection of other components and cubicle metal work can be dealt with as for other marine equipment.

Both germanium and silicon rectifiers (either forced air cooled or naturally cooled) offer possibilities for marine use, mainly because of the flexibility of layout and rating obtainable for particular applications, whether for supplying d.c. to individual machines such as winch motors, or for providing general d.c. power supplies, as in the case of the 27·5 kW rectifiers supplied recently to Cammell Laird and Company and installed in the gas-turbine ship Auris.

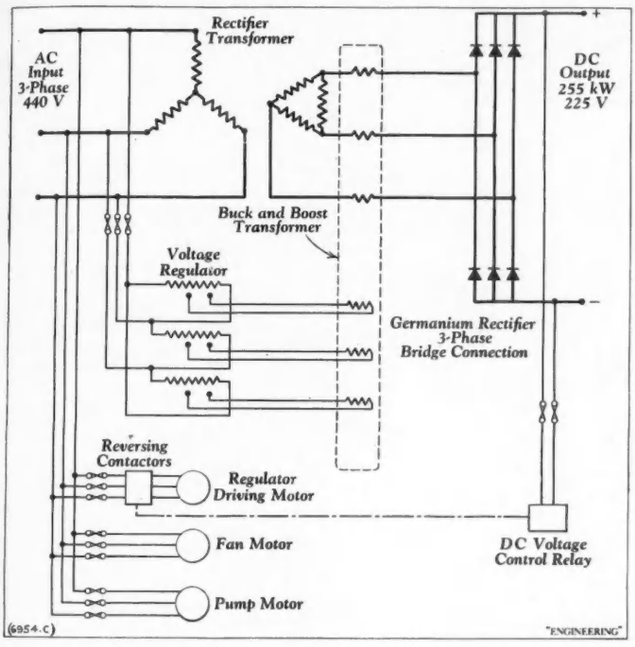


Fig. 1 (left) Diagram of main connections.

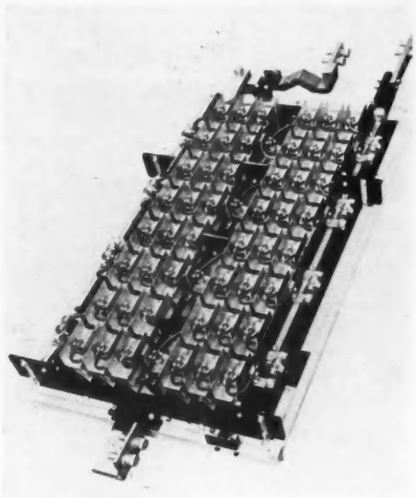


Fig. 2 (top right) Close-up of rectifier tray.

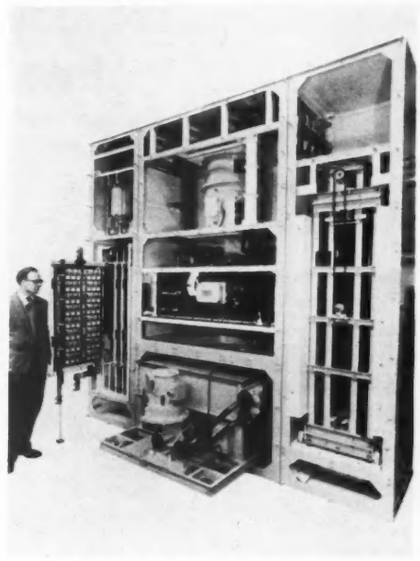


Fig. 3 (right) The complete assembly with covers removed.

Diesel Engine for Alternator Set

Ruston and Hornsby Limited, of Lincoln, have received from the Air Ministry orders totalling more than £500,000 for a number of 410 kW skid-mounted standby alternator sets. Each set is powered by a 12YHX diesel engine made by their associate company, Davey, Paxman and Company Limited, Colchester, Essex.

The 12 YHX is a 12 cylinder, four-cycle, pressure charged engine, with a bore of 7 in and a stroke of 7¾ in; the cylinders are set V-formation.

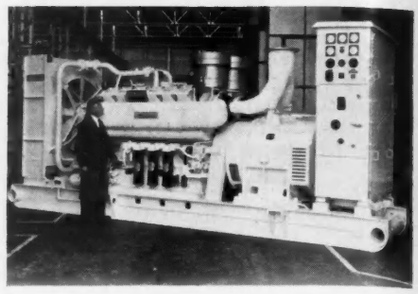
A cast iron crankcase carries the cylinder blocks on faces machined on the upper surface, and the underslung crankshaft and main bearings in bearing housings located against side thrust by deep fitting faces. Additionally, lateral tie rods pass through the crankcase and caps to give an extremely rigid assembly. The cylinder blocks are arranged in two banks at an included angle of 60°. Wet type free fitting liners inserted in the cylinder bores are of special cast iron. The underside of the crankcase is enclosed by a sheet metal sump.

The forged steel crankshaft, ground on all wearing surfaces and drilled for lubrication of the large end bearings, is carried in main bearings consisting of steel shells lined with copper lead material and lead flashed. The shaft is located by one of the bearings and is flanged at the drive end to receive coupling bolts. A spring drive at the free end is provided for driving through a gear train, the oil and water pumps, dynamo and tachometer. A flanged coupling is provided for mounting the damper (if required) and for power take off.

Machined from steel stampings, the fork and blade type connecting rods are carefully matched for weight and balance. A large end block attached to the forked rod houses a replaceable steel-backed copper-lead lined, lead flashed bearing shell, which runs on the crankpin. A similar bearing shell in the blade rod runs on a chromium plated outer surface provided on the large end block. The small end bushes are of silicon bronze.

Aluminium alloy oil cooled pistons, having an austenitic iron insert for the top pressure ring, are fitted with three compression, one oil control and one scraper ring, the piston crown being machined to form the combustion chamber. Pistons and connecting rods can be removed through the crankcase doors. Fully floating gudgeon pins are located by circlips.

Cylinder heads are in single units and fully interchangeable. A spigot ring bearing on a copper ring seals the cylinder head against gas and water leakage. The lower end of the liner is sealed by two rubber rings. Water transfer from the blocks to the heads is by ferrules There are four valves per cylinder and a centrally disposed injector retained in position by a clamp. The valve rocker gear consists of one push rod and rocker per two valves; a bridge piece actuates each pair of valves. The valve gear is totally enclosed by easily removable covers.



The camshaft, with its pressure lubricated bearings and roller type cam followers, is located in a separate housing, so it is quite easy to remove the complete assembly without disturbing the cylinder blocks. The camshaft is chain driven from the drive end of the engine.

An all speed governor, driven from the engine camshaft, is of the flyweight hydraulic servo-assisted type and controls the effective stroke of the injection pump plungers by means of individual spring loaded levers from one shaft mounted in ball bearings. Automatic advance and retard mechanism can be provided and a hand control is fitted for shutting down the engine. The governor uses engine lubricating oil as the operating medium and this protects the engine if there is a failure of oil.

Diesels for Supertankers Give 1,800 b.h.p. per Cylinder

High powered diesel engines have been left behind by steam turbines as propulsion plants for supertankers and large fast freighters. A tanker of 100,000 tons displacement, with an operating speed of 15 to 16 knots, requires a propulsion plant of some 25,000 b.h.p., usually in a single unit to facilitate control and installation. But the largest diesel engines built during the period 1950 to 1955 were only rated at 12,000. b.h.p., so that, without doubling the power output of their engines, diesel manufacturers could not hope to retain the business. In fact, steam turbines gained a leading position as power plants for large tankers. Diesel manufacturers are now attempting a come-back.

The feature that rescued a share of the market for diesel engines was fuel economy. In one year of operation a diesel-powered supertanker may save £100,000, and such an advantage gave diesel manufacturers considerable impetus to develop the required power plants.

Nine years ago MAN (Machinenfabrik Augsburg-Nurnberg) started development of a suitable single-acting two-stroke engine. The KZ 78/140 originally developed 900 b.h.p. per cylinder; with the introduction of supercharging this was later increased to 1,200 b.h.p. Owing to the conservative design and relatively short stroke of this engine (55 in), the makers were able to extend the stroke and reintroduce the model as KZ 78/155 with approximately 61 in stroke. A suitable test engine was built with six cylinders, and the arrangement was such that scavenge air could be drawn from any one of three cylinders, using the return stroke of the piston as a pump. Power rating of the cylinders can be conveniently varied by the number of cylinders that are used to supply scavengé air. With two cylinders operating as pumps, the power rating was 1,350 b.h.p. per cylinder. Adding one more cylinder to pump scavenge-air, the power rating was boosted to 1,500 b.h.p., which represented the maximum development of the engine. Such a power rating still fell short of the requirements of large tankers: some 16 cylinders would be required to produce 25,000 b.h.p.; an impractical proposition in a single unit.

As the existing engine series could not be developed any further, about two years ago it was decided to construct an entirely new engine (KZ 84/160) with a stroke of 63 in and a 33 in bore. A three cylinder test engine has been built and at 115 r.p.m. this produced 1,700 b.h.p. per cylinder during the initial trial period. The fuel consumption was considered quite satisfactory at 0·033 lb per b.h.p. hour, about the same as the fuel consumption of the smaller machine. Owing to the conservative design of the engine's structural components the ultimate power rating may be raised to 1,800 b.h.p. without any changes in design, permitting the construction of a 22,000 h.p. power plant with 12 cylinders. Only the largest vessels now planned, representing a small proportion of present ship construction, require power in excess of the capability of this engine.

Without any new invention or change in construction methods, the power rating of marine diesel engines has been increased from 1,200 b.h.p. to 1,800 b.h.p. per cylinder, an increase of 50 per cent. Specific fuel consumption remained unaffected, but the physical size and specific weight of the engine is now rather on the high side. MAN consider this as the price of fuel economy, and believe that a specific weight of 90 lb per b.h.p. would be acceptable if installed in the stern of large tankers. Compensation for increased weight should result from the reduction in the amount of fuel carried.

Four Cylinder Industrial Diesel

A 60 b.h.p. industrial diesel engine has been developed by Perkins Engines Limited, Peterborough. It has a number of longer-life features and will give operators the advantages of low-cost running and maintenance.

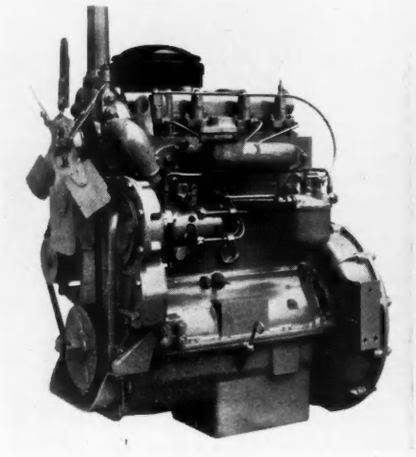
This four cylinder in-line addition to their wide industrial range is known as the Four 203, following the current Perkins practice of denoting the engine by the number of cylinders and its capacity (cu. in). For variable speed applications, such as fork-lift trucks and mobile cranes requiring between 2,000 and 2,400 r.p.m., the engine is available with a hydraulic governor, and is rated up to 60 b.h.p. at 2,400 r.p.m.

The Four 203 has a high power-weight ratio and develops up to 47 b.h.p. at 2,000 r.p.m. for continuous use when fitted with a mechanical governor. The maximum torque is 151 lb-ft at 1,350 r.p.m. intermittent rating.

An attractive feature of the engine for industrial operators is the practical method of meeting power take-off requirements. Timing is accomplished through a geared drive, which gives improved running conditions and allows power take-off from the gearing at two points. Facilities are available for driving, off the camshaft gear, a hydraulic pump, with a capacity of up to 17 gallons per min at 1,700 lb per sq. in, to operate main hydraulics such as fork lift truck equipment. Provision is made also for a hydraulic pump beneath the fuel pump, a point particularly suitable for power-assisted steering systems.

The extra-life features built into the Four 203 include chromium plated steel, thin-wall liners as a standard fitting. The liners are pressed into the cylinder block and are easy to replace.

The Four 203 has the well-tested Perkins combustion system, with twin-hole injectors.



(*Above*) *The Austin 4-wheel drive Gipsy as a pick-up truck. It has a glass fibre cab, reinforced with steel at vital points.*

(*Above right*) *On the M1 motorway: the Leyland Super Comet truck and a rear-engined Atlantean double-deck coach.*

(*Below right*) *One of the 85 m.p.h. long distance coaches built by the Birmingham and Midland Red Omnibus Company. It has disc brakes and the engine has been turbo-charged and an overdrive gearbox fitted with a ratio of 0·73 to 1.*

(*Below*) *The E. Boydell and Company Limited Muir-Hill 14B hydraulic dumper, capacity 4½ cu. yd, fitted with quarry body and water-quenched exhaust system, recently exported to Yugoslavia and Greece.*

(*Left*) *Guy Motors Limited Wulfrunian double-decker with all-metal body seats 77 passengers. The stairs are located forward and it has air-suspension.*

(*Above*) *One of the twenty high capacity British United Traction Limited trolley buses, in service with the Portuguese Municipality of Oporto.*

Travelling Crane Aids Shipbuilders

The Greenock Dockyard Company Limited are modifying their shipbuilding procedure and methods. Their scheme includes the prefabrication of large sections of the ship hull in the new welding shops and transporting them to the slipways. The yard has been completely rearranged and this has necessitated an adjustment to the number of slipways and the building of reinforced concrete roadways, including crane tracks.

To serve the slipways, four Butters Brothers and Company Limited travelling Monotower cranes have been erected. This type of crane has certain advantages over the older types of crane used in shipbuilding. The relatively light luffing jib is easily operated and can be introduced to overcome many of the setting problems that present themselves to shipbuilders, especially when more than one lifting hook is required and the cranes are working in groups. The jib also presents a reduced area to the wind, and so the cranes can work in higher wind velocities than the older types of cantilever crane.

With the luffing jib heel pin set at a level to suit the height of ship being constructed in the slipways the desired height of lift and clearance can be easily attained without a high supporting tower. This has a beneficial effect in reducing the wheel loads, thereby reducing the cost of piling and reinforced concrete work.

These Monotower cranes have a maximum lifting capacity of 25 tons. Loads up to this value are lifted at a radius of 90 ft (measured from the track centre) to a minimum radius of 30 ft. The main hook lifts loads up to 20 tons at 100 ft radius and 10 tons at 122 ft radius. The cranes are fitted with an auxiliary lift which handles loads up to 3 tons at a maximum radius of 130 ft. The jib length is 125 ft from the jib bottom fulcrum pin to the main lift pulley pin at the jib point.

The main hoist is operated by a 60 h.p. motor and arranged to give two speeds of lift, namely: loads up to 25 tons at 23 ft per min; and loads up to 8 tons at 70 ft per min. These loads are lifted on a single pulley return block fitted with a safety type hook mounted on a ball-bearing swivel. The auxiliary hoist motion lifts loads up to 3 tons at a speed of 150 ft per min. This motion is driven by a separate 45 h.p. motor. The luffing motion is driven by a single 40 h.p. motor giving a speed of 40 ft per min with the full load of 25 tons. A 35 h.p. motor drives the slewing gear, developing a speed of 250 ft per min at 90 ft radius with the maximum rated load suspended.

The crane travels on a double rail track set at 30 ft centres with a 16 ft high portal opening at the foot of the 75 ft high tower. The crane is mounted on 16 centre-flanged rail wheels, eight of which are driven in pairs by four 16 h.p. motors developing a geared travel speed of 50 ft per min.

All motions of the crane are controlled from the operator's platform located at the front of the revolving portion of the crane. The platform level is above the tower top level, so that the operator has a clear view of the various loads the crane lifts.

The introduction of these Monotower cranes in this yard in particular, and in British shipbuilding yards generally, has proved to be a most efficient and economical method of handling the large prefabricated sections employed in shipbuilding practice today. Butters are at present constructing cranes of 100 tons capacity with a radius of 122 ft for a leading British shipyard.

It is also worthy of note that a number of foreign shipbuilding yards have also introduced these cranes. In some cases repeat orders have been received to confirm their success. One of the cranes is shown in the illustration on the right.

Swing Hammermill for Australian Quarry

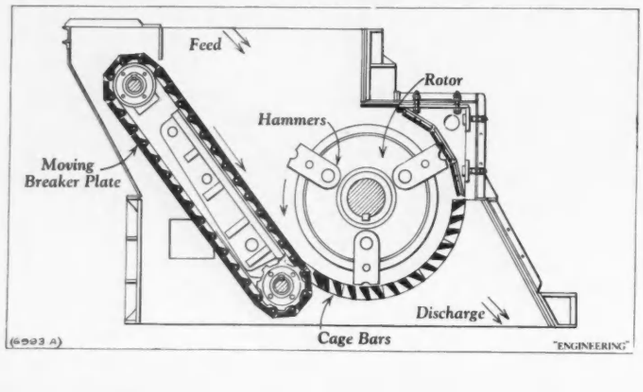
A 72 in by 60 in Pennsylvania-Dixie non-clog hammermill, type DNC, the largest swing hammermill ever built in Britain, was recently completed in the Erith Engineering Works of the General Electric Company Limited of England for installation in the quarry of Adelaide Cement Company Limited, South Australia. It can take 48 in pieces of rock and break them into pieces less than 1 in, at a rate of more than 350 tons per hour.

The machine works on the same principle as a conventional hammermill. The material is crushed by revolving hammers against a breaker plate and swept through cage bars at the bottom, to give the finished product. The rock at Adelaide Cement Company's quarry contains clay. When wet, this might stick in the feed opening and eventually block it completely. This hammermill is designed to overcome these conditions. A downward-travelling breaker plate is provided to pull the sticky material continuously down into the crushing zone of the hammers, where it is broken up and forced through the cage bars. The moving plate prevents the feed opening from getting choked.

The crusher frame is of welded construction. The breaker plate, which weighs 7 tons, is made in two halves for convenience in manufacture and installation, each half consisting of a series of manganese steel plates linked together in an endless chain. Plain trunnion wheels support the links at the top, and they are driven from the bottom by toothed sprocket wheels connected to an independent motor through a reduction gearbox. The breaker plate is backed by a massive steel bedplate of welded construction, the purpose of which is to give solid anvil crushing under heavy shock loading. The breaker plate can be regulated for tension and can be adjusted also as a unit with the bedplate to give any desired clearance from the hammer tips. The interior of the mill is protected by liners cut from wear-resistant manganese plate.

The rotor shaft (which is made of chrome-molybdenum steel) has shrunk on to it 6 discs, each 3½ in thick, from which the hammers are suspended. The whole assembly of hammers, flywheels, bearings and a half-coupling, weighs just over 25 tons. It has a direct motor drive through a flexible coupling. The shaft is carried in SKF self-aligning roller bearings fitted with a thermostatic control which stops the machine if the bearings overheat. The bearings are lubricated by circulating oil. Bearings, flywheels and the driven half-coupling are mounted on the shaft on taper seatings by means of the SKF oil-injection system, no keys being necessary.

The whole mill is of massive construction and weights 70 tons complete. The rotor assembly is driven by a 650 h.p. motor.



(Left) Layout of the Dixie non-clog hammermill.

(Right) The rotor being dropped into position.

Does the Lorry Cab Suit the Driver

Fatigue can be an important factor in road safety. When the British Motor Corporation designed their new cab for 2, 3 and 4 ton forward control lorries in the Austin and Morris range, special attention was given to the method of entering and leaving the cab, and to improved visibility for the driver. In order to see exactly what the effects of the new design were, BMC submitted vehicles for independent test by Professor G. C. Drew, Professor of Psychology in the University of London.

Using a team of ten men chosen as average drivers, Professor Drew carried out a series of three tests, the first of which was to determine the energy requirements for entering and leaving the old and new cabs. By measuring the oxygen consumption of the individual drivers it was possible to calculate the energy expended in calories per min., and it was found that entering and leaving the old style, conventional cab demanded nearly three times the energy needed for the new type. The mean energy requirement for the conventional cab, 10·1 cal per min, is greater than that recorded for many activities in industry, including pick and shovel work, and also exceeds that needed for most occupations in mining. On the other hand, the energy requirement for the new cab, 3·4 cal per min, compares favourably with many activities listed as medium in light engineering and with some tasks of a non-engineering nature, such as tailoring.

A second series of tests was carried out to see whether the extra visibility provided made it easier for the driver to manoeuvre the vehicle. This was done by timing reversals into a loading bay, and alongside a kerb stone. Since the drivers were familiar with the old style cab and not with the new one, some advantage in favour of the old design could be expected, and this was, in fact, shown by the figures. One significant fact which emerged was that the effect of practice in repeating the same test was more marked in the old cab than the new. From this fact it is reasonable to draw the conclusion that the improved visibility of the new cab makes the task of manoeuvring much easier.

The third series of tests was designed to measure the development of fatigue in the two types of cab during a normal day's work. These tests were based on the fact that a fatigued individual normally works harder than when he is fresh to achieve the same result. A driver tends to make more movements of his controls and to exert greater effort in making the movements. To measure this effect the vehicle steering wheels were machined so that a polythene tube could be embedded round the edge. This tube was sealed at one end, filled with water, and connected to a small bellows, which was arranged to record, on a counter, an integration of grip with time. A 16 mm camera took a photograph of the counter dials automatically every 6 min. A graph of the results obtained showed that drivers using the conventional cab increased this grip on the wheel during the day, the rise being small and gradual. With the new cab a very different picture emerged, the graph showing a progressive decrease in grip which, at the end of the day, was significantly less than that for the comparable period in the conventional cab.

Because the tests were necessarily of limited extent, it is not possible to draw too many conclusions, but it is safe to say that the new cab shows a marked improvement in three respects : reduction of entering and leaving fatigue, improvement in ease of manoeuvrability, and reduction of overall fatigue in a day's work.

Dust Extractor at Harwell

A unit dust collector from the standard range made by Dallow Lambert and Company Limited, Thurmaston, Leicester, and used at Harwell, is shown in the accompanying illustration.

It controls the dust created by the lathe seen on the left of the illustration and the drilling machine in the background. Extraction from the lathe is very nearly absolute, but the drill hood is arranged for collecting airborne dust only. This hood, being connected to the unit dust collector by means of a flexible pipe, can be moved about and used as a cleaning nozzle.

Fabric filter pads in the collector arrest the dust, which is dislodged from the filter surface by a mechanical shaker. The dust is slightly radio-active, and is held in a polythene bag within the collecting bin for safe removal. Radio-activity in the unit is checked regularly.

Radar on the River

Decca Radar Limited, Albert Embankment, London, SE11, pioneered the use of radar on rivers and canals, and over 300 of their type 214 installations have been proved on the Rhine and other European inland waterways. New equipment, type 215, has now been introduced. It comprises a scanner unit, a combined transmitter/receiver and a display unit, together with associated power supply, the equipment being compact and suitable for all classes of vessel.

The display unit is suitable for installation either on a pedestal or on a bulkhead; the latter is its usual place, to conserve space in the wheelhouse. Seven closely spaced range scales of 0·4, 0·8, 1·2, 1·6, 2, 5, and 10 km are provided on a 23 cm cathode ray tube. Nautical and statute mile versions are also available. Each range can be off-centred by half a radius to provide increased warning ahead on the scale in use. On the 400 metre range there is a picture on twice the scale of the original Decca river radar; this is suitable for very narrow waters, or for the actual entry into a lock. An optical magnifier (1·7 ×) can be used to increase the effective scale. Two pulse lengths of 0·15 and 0·05 microsecond are available, and these enable optimum performance to be obtained at short ranges where high discrimination is essential, or a larger range where good detection, particularly of small navigation buoys, is more important.

The transceiver is a compact bulkhead mounted unit, which, as it carries no controls, can be mounted in any convenient position within 6 metres waveguide run of the scanner. Peak power is 20 kW, and the pulse repetition frequency 1,000/sec. A short pole mast, which can be retractable when low bridges have to be negotiated, is the normal mounting for the aerial, which is a horn-fed tilted parabolic cylinder of 2 metres aperture. It rotates at 24 r.p.m., has a horizontal beam width better than 1·2° at half power points, and the side lobe level is low for use in confined waters.

Power supply is taken from a 420 W motor alternator with a separate voltage regulator.

Two new types of rate of turn indicator have been designed to replace the original Decca model. These provide the helmsman with an accurate and sensitive heading reference, and the two types have different degrees of sensitivity for use in vessels with fast or slow swinging rates. Power supply is from a small motor alternator.

Hoisting in a Confined Space

When the height from the floor to the roof is restricted, electric hoist blocks of the orthodox type take up too much of the space available for lifting goods.

To overcome this particular problem in a London engineering works, the Taylor Stoker Company Limited, 189/191 Drummond Street, London, NW1, have recently installed a Taylor "Lo-Hed" hoist, on which the bottom block and hook can be drawn right up into the hoist frame. The hoist has all the normal safety features, including an automatic over-wind prevention switch and an automatic lowering and load-sustaining brake. It has a hoisting and lowering speed of 20 ft per min, and is controlled from a pendant push-button panel, suspended from a flexible cable. Traverse is manual, by hand chain, and the hoist is designed to negotiate sharp bends; in this particular installation it has to travel round a sharp S-bend.

Automatic Control in the Soviet Union

Automatic control in Russia is at present behind that in Britain, but will catch up in a few years. A considerable research effort is the main reason for coming to this conclusion.

For a number of years now, individuals and delegations have been going to the Soviet Union and coming back with reports. The latest effort gives an account of the observations of a team of six British engineers, headed by Professor A. Tustin of Imperial College, who visited Russia as part of an arrangement for an exchange of visits by experts on automatic control. Like many of their predecessors, they concluded that the Russians will have overtaken Britain in their field of interest within a few years.

The delegation considered that the chief function of their visit was the opening up of channels of information and the establishment of personal relationships. In this respect they consider that they were successful, and as a result of the visit they found themselves able to come to one or two firm conclusions which they report. They found that work is in progress in laboratories in the Soviet Union in most fields of industrial control and in most of the distinctive classes of device that are known to the delegation to be in process of development in Britain. Analogue computers are extensively used, and digital machines are rapidly becoming freely available.

They report that, in general, this work is at present on the average not so advanced as in Britain. In particular, little evidence was seen of work on the more advanced forms of control of chemical processes. On the other hand, there is considerable activity on control in the steel industry, particularly in the development of integrated process control simulators, both as a guide to design of multi-variable control systems and also to operate as part of such control systems. Work is well ahead in telemetering (for example, as applied to the control of long gas transmission pipelines) and on the control of electric power systems with long transmission lines. This work is mainly on similar lines to work in progress here, but seems to have been given some degree of priority because of the special needs of the Soviet Union. There seems, however, to be less attention paid to project evaluation than is usual in industrial research in this country. There is some evidence of duplication of effort in certain fields, but the facilities for publication appear to be good and there are conferences which may suffice to prevent wasteful duplication developing any significance. There is no close equivalent in the Soviet Union to the Institution of Electrical Engineers.

GREAT POTENTIAL

The potential which is being built up for further developments in automatic control and automation in industry in the form of large well-equipped research organisations and numbers of engineers trained is great. Of the five research institutes that were visited, two had been established for only two years and one for three. At the Central Institute for Automation of the Ukraine, at Kiev, which has at present 700 employees, the group were shown plans for new buildings, to be completed in three or four years, providing for an increase in the number of personnel to 4,000. This institute will be for developments of automation in heavy industry, including chemical and metallurgical plants and mines, and to some extent parallels the field covered by the Central Institute of Automation in Moscow.

It is evident that institutes only two or three years old cannot yet have made their weight felt in industrial applications, so present achievement is no proper measure of potential for progress. It is also evident that the rate of increase of this potential is rapid. Research institutes engaged in automation usually have small batch production units for production of instruments and apparatus necessary for automation.

Such observations as were made of establishments for engineering education, confirmed in the minds of the party the conclusions of others that the effort being made is massive and effective. They were told that 83,000 students graduated in engineering in 1958. The nature of the centralised planning probably ensures that the trained personnel necessary for the planned rate of expansion of laboratories will be met. The connection between teaching, research and industry is good, and there is a good deal of interflow of personnel between these activities. The groups in Britain for research and development in civil applications of automatic control are very much smaller than those now existing in the Soviet Union, and the contrast is still greater in respect of expectations for the near future. The impression was gained that, in a few years, the application of automatic control in Soviet industry will have overtaken that in this country. The stage will then be reached at which leadership will depend upon the breaking of new ground. It is easier to catch up than to surpass. There is little evidence at present on which to judge how good the Soviet will prove to be in this further stage, but it is acknowledged that their present level of achievement in basic theoretical work is high, and in other fields initiative has not been lacking.

INFORMATION EXCHANGE

The group report that these speculations at least lead them to the general conclusion that it will be increasingly useful to maintain and open up communications with Russia in this field. In the field of automatic control there will be an excellent opportunity to carry this a stage further on the occasion of the conference of the International Federation of Automatic Control, to be held in Moscow in July, 1960. It is also becoming important to ensure that a larger proportion of British engineers acquire enough knowledge of the Russian language to be able to use Soviet technical literature.

The impression was gained during this visit that the Soviet engineers working in the field of automation were glad to have the opportunity of discussing technical problems with their British counterparts, and that the constructive approach they brought to these discussions bodes well for further technical exchanges of increasing scope and frequency to the mutual advantage of both parties.

As well as visiting several educational establishments, computing centres and factories, the delegation visited five research institutes under the Academy of Sciences of the USSR. The names of these five institutes make fairly impressive reading and it would be hard to find any counterpart in Britain. They were the Institute of Automatics and Telemechanics in Moscow, the Institute of Precision Mechanics and Computer Techniques in Moscow, the Institute of Electromechanics in Leningrad, the Central Scientific Institute of Complex Automation in Moscow, and the Institute of Automation of the Ukraine in Kiev.

Mention was made in the report of work on the control of machine tools at three of the establishments visited. The Institute of Electromechanics has developed a computer for milling machine control. During the visit, the people who had developed it were away in Moscow testing the machine. The delegation were, however, able to have a look at a paper about the machine which is being prepared for the IFAC conference next year. The machine approximates curves by polynomials using digital differential analyser techniques to generate the polynomials from their differential equations. The integral part of the output registers of the integrators are not necessary since they carry pulses across the decimal or binary point are used directly to control the drives on the machine tool. The paper describes various arrangements of integrators for producing polynomials in different ways.

COLLABORATION

At the Institute of Automation of the Ukraine, a turret lathe has been converted to automatic operation from punched cards. A magnetic drum has been fitted to the lathe, and it appeared to the delegation that marks are written on this according to codes on the card and these marks are used as the limit settings for the operations. Accuracy of turning was stated to be [only] 0·05 mm. This work has been done in collaboration with the machine tool makers and a model is being shown at the Kiev industrial exhibition. The laboratory has also developed a special-purpose computer for converting design data to data as used on the machine tool. The input is in the form of coded dimensions, punched by hand on tape from the drawing.

Research work into programmed machine tool control was also reported at the Institute of Electrotechnics. This was an automatically positioned drilling machine. The programme is punched on cards and the feedback of position is by an optical system; drive is by d.c. machines.

At the Institute of Automatics and Telemechanics a system of automatic control on cold reduction tandem mills has been proposed for a four-stand mill, and its design and performance studied with the assistance of an electronic analogue of the last three stands. The delegation reported, however, that there seemed no evidence available of its practical trial on a mill.

CAR FACTORY

One of the factories visited by the delegation was a light car factory in Moscow, where the Type 407, 45 h.p. sedan known as the Moscovitch is made. The output of the factory was 210 cars per eight-hour shift, the labour expenditure being 230 hours per car.

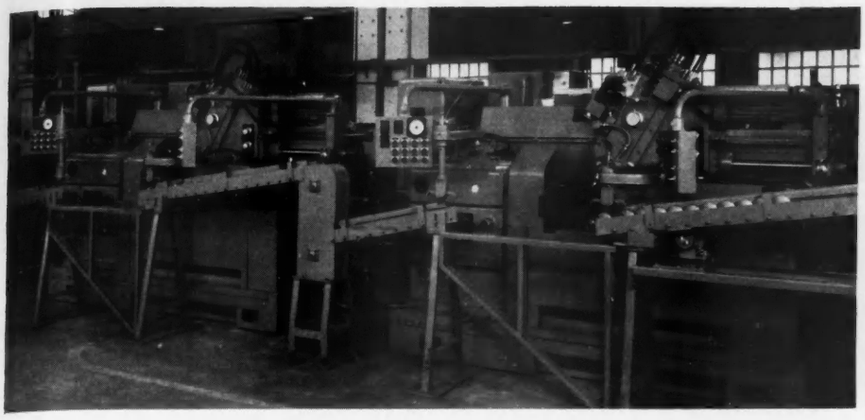
Questions were asked here to elucidate the extent of automation and the replies seemed to show that there was no special aim to introduce mechanisation beyond the usual modern practice. For example, when asked whether special purpose multiple head spot welding machines were used in fabrication, the chief engineer said that they had been considered but rejected as not being economical in a plant of that size. When asked about the basis on which such decisions were made he was vague, and finally said that if a machine had a production rate much higher than required so that its installation would involve much idle time, then he would regard it as inappropriate for the plant. He made it clear, however, that this was a matter for accountants and he was an engineer. He was thinking of " appropriateness " of production method rather than a cost criterion.

He said that the problem of bringing the required parts together at the assembly point was solved by lists being given for each day's and each month's production, and that any method of solving this problem more simply would be very welcome.

The manufacturing methods seen in these shops were reported by the delegation to be broadly those already familiar in the British car industry some years ago. A few transfer machines are used for such operations as drilling, reaming and facing on cylinder blocks and heads and some other parts, but not in the production of turned or ground parts.

Other subjects covered in the report include the automation of power stations, gas and steam turbines, non-ferrous metal production, blast furnaces, open hearth furnaces, and electric arc furnaces.

Production



Two of the Churchill-Redman machines fitted for automatic loading and unloading and providing for automatic transfer from one machine to the next.

Automatic Loading and Unloading

An automatic loading and unloading mechanism has recently been made available on the Churchill-Redman P5 automatic multi-tool and profile-turning lathe. The arrangement also allows the workpiece to be transferred from one machine to another by a conveyor and elevator system.

The chief components of the mechanism are two pivoted arms, one for loading and the other for unloading, fixed to the tailstock and headstock of the lathe respectively. Each arm forms the radius of a circle on whose circumference there is, at one point, the on or off loading conveyor and, at a second point, the working position of the workpiece. At the end of each arm there is a gripping device which holds the workpiece while it is being transferred from one position to another. The control system is a combined electrical and hydraulic device designed to fit in with the control of the lathe.

When the machine is loaded, the first arm grips the component in the input conveyor, swinging it into the machine, and the tailstock advances, moving the component into the open jaws of a three-jaw compensating chuck. The arm then releases the component and returns to its starting position over the conveyor. As the arm is returning, the machine cycle starts.

When the machining has been completed, the unloading arm swings into the machine and grips the component, the tailstock retracts and the chuck jaws open. The component is then moved clear of the jaws and swung over on to the unloading conveyor before being released. After this, the component rolls down the unloading conveyor under gravity to a position where it is picked up by an elevator to be lifted on to the input conveyor of the next machine. The operation is then repeated on the second machine.

Increasing Productivity

New methods introduced recently by J. H. Carruthers and Company, Limited, of East Kilbride, are reported to have resulted in an overall increase of productivity coupled with increased earnings by the workpeople. The company were previously faced with many problems arising from lost time and with an incentive scheme which was unsatisfactory to men and management alike. They therefore called in Personnel Administration Limited, management consultants, who introduced a new plan.

The old scheme was based on " allowed times " for the various operations and developed from tradition and bargaining, a bonus being calculated separately for each job according to the " time saved " and paid on top of time-wages. In the new incentive scheme, times are set for each job in standard hours based on work study, cards giving detailed methods are handed to the operatives for each job, and the management are provided with weekly summaries for each shop section giving the particulars of the hours worked, the portion in standard hours spent usefully, and lost time and its causes.

Weekly wages are now calculated in one operation, totalling standard hours of production on all jobs in one week, together with lost time and translating these into money.

As a result of the simplification of wage calculations, it has been possible to produce the weekly summaries without taking on extra staff. It is also reported that the production flow has been smoothed, particularly where new employees are involved, and that there has been an improvement in the prompt issue and return of tools, gauges and drawings.

" Lost time "—the time when an operative is non-productive because he is held up while waiting for tools or to commence or continue an operation—was cut considerably because the weekly summary shows where and when avoidable lost time is occurring.

The Challenge of Human Relations

" As production engineers we are facing an acceleration in the rate of technological progress which is quite frightening, and indeed this is not surprising if it is true that of all the scientists and technologists who have ever existed since the dawn of history, 75 per cent are still alive and working today. The degree of specialisation now necessary is reflected in the greatly extended syllabus of our new examination which comes into force next year. But, it is abundantly clear to everyone that this progress in science and technology is not in any way matched by similar progress in human relations. This situation is, I am sure, both a challenge and an opportunity which our institution should accept in the coming years."

This remark was made by Mr. G. Ronald Pryor, president of the Institution of Production Engineers, in the course of a speech at the Institution's annual dinner last month.

Marketing

Production Index Rising

Increasing industrial activity is accelerating the rise in the official index of industrial production. Adjusted for the seasonal effects, this year's figure for October, 114-5, is between nine and ten points higher than the corresponding figure for 1958. The rise, comparing Septembers in the last two years was of nine points and comparing Augusts was eight. For the first three months of the year the increase was only one point.

Although the employment figures are better than in 1958 there were 431,000 unemployed in Britain on 16 November, an increase of 12,000. There is a seasonal decrease in employment at this time but the 12,000 were all among the wholly unemployed.

In Northern Ireland, where 6·9 per cent of the working population is unemployed, the number idle increased over the month by only 100 to a total of 33,000.

Smithfield Machinery

This year's Smithfield Show, running from 7 to 11 December, in its reorganisation of the judging arrangements to allow the public to follow these esoteric rites, recognised that as in many other markets so in agriculture the consumer now calls the tune.

The second half of the full title is Agricultural Machinery Exhibition and from the AC-Delco division of General Motors right through the almost four hundred exhibitors to Roadless Traction and Wright Rain the glittering equipment of the most mechanised farming nation in the world was there to remind the urban visitors how technical a business getting the harvest home has become.

Representation of foreign agricultural machinery makers has for long been through their British concession holders but at this Smithfield on a stand of their own were the West German firm of Alexanderwerk AG of Remscheid.

In common with the increasing volume of Anglo-German trade, agricultural machinery movement between the two countries is going up. In the first nine months of this year British tractor exports to Western Germany are above the same period of last year by 30 per cent and agricultural machinery exports as a whole are 12 per cent better.

Egypt Buys Comets

Resumption of diplomatic relations with Egypt may well speed up the renewal of BOAC services through Cairo, still held up by delays over the de-sequestration of the corporation's property there.

Meanwhile the Egyptian air line, Misrair, have contracted with De Havilland for three Comet IV's at a cost of £4 million. Delivery is expected some time next June and Misrair, a state concern, may operate at least one of their new jets on a Cairo-Paris-London route. Those who still think of the United Arab Republic as being entirely orientated towards the Soviet bloc in economic matters may reflect that Misrair made their decision in favour of the Comet IV despite offers some time ago of the TU 104.

Orpheus in the Orient

The Japanese defence agency have placed " a substantial order " for Bristol Siddeley Orpheus 805 turbojet engines. The Orpheus, rated at a 4,000 lb thrust, has been chosen for the Fuji T1F-2, a standard intermediate and advanced trainer for what is known in Japan as the Air Self-Defence Force.

Engines in Bristol Siddeley's Orpheus family have now been specified as the powerplant for fourteen different aircraft. Orpheus engines have so far been installed in considerable numbers in aircraft of seven of these types.

Marketing

Massey-Ferguson Reorganise

A new form of organisation on a world-wide basis has recently been announced by Massey-Ferguson Limited, Toronto. They have created a corporate management group who will be responsible for the expansion of the company's operations throughout the world. The re-organisation has involved the creation of five centres of operation each headed by a general manager, in North America, the United Kingdom, France, Germany and Australia. The new group of corporate executives who had previously been mainly concerned with direction of the company's North American activities, will now be free to assist the president, Mr. A. A. Thornbrough, in the integrated management of the company as a whole.

The chairman of the company, Colonel W. E. Phillips, described the plan as a " logical development in the field of organisation made necessary by the remarkable improvement in our position during the past three years." The acquisition of F. Perkins and of the Standard Motor company's tractor assets have considerably increased the size of the concern and emphasised the importance of an effective world-wide organisation. The new plan became effective on 1 November. Corporate staff office premises have been bought in Toronto.

Spanish Clear Up

A contract for the disposal of $3 million of plant which was used in the construction of the United States naval base in Spain at Rota, has been awarded to the George Cohen company. The Rota project which involved the creation of a completely new harbour in the bay of Cadiz (within three hours drive of Gibraltar) cost $65 million and was undertaken as a joint venture of Corbetta Construction, of New York, and Construcciones Coviles, of Madrid. It involved the construction of a 1½ mile breakwater and marginal wharf, petrol, oil and lubricants pier, and other major facilities.

The plant concerned has had to handle millions of tons of rock and thousands of tons of concrete. It is of the most modern type and was supplied by British, American and Continental manufacturers, all of it since 1956. It includes earth moving equipment and dumpers, many types of cranes, one of them a 100-ton capacity gantry crane used for positioning pre-cast concrete blocks during the construction of the main wharf; compressors; piling equipment; welding sets; machine tools and concrete batching plant of the Winget Koeling type. Most of the plant is being checked, overhauled and reconditioned on site where excellent workshop facilities were set up for maintenance. Most of it will be exported and Cohens are establishing a branch office at Rota.

Customer Rights

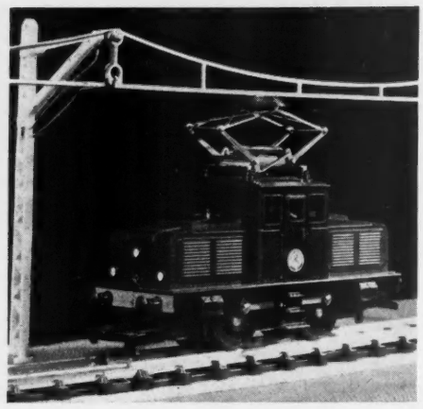
There is a growing need in the contracting and building community of a 24-hour delivery service for the plant and materials they use. Key Engineering have announced the institution of a round-the-clock delivery service of their 4 in or 6 in pitch fibre pipe for underground or stack drainage. With the exception of a few outlying districts all orders for full loads will be delivered within 24 hours, on receipt of a telephone call.

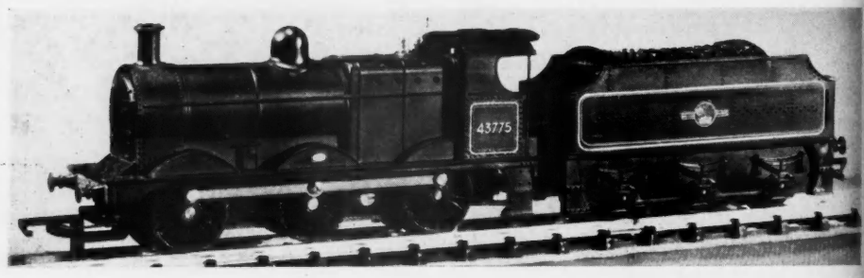
At Home

Small Problems

There should be a very nice distinction between a toy and a model but quite what it is, is doubtful. A generation ago a line could have been drawn fairly clearly: a toy was played with and bore only a vague resemblance to the real thing, a model was for show and was correct in detail.

This line is now drawn so fine as to be almost non-existent. Toys are now exact, or as nearly exact as cost will permit, copies of the original thing; if they are not, the fact is reflected very quickly in falling sales. The Lines Brothers group are now among the largest toy manufacturers in the world and their experience bears this out. A new item will only sell if it is more detailed and more exact than a previous one. Children now want not just a lorry, but a " mark 4 Laird with forward drive and 10 ton body "—and they know what it looks like, too.





(*Left*) *The fitting of a power unit into a steeple cab locomotive (which can draw its supply from either the catenary or the rail) has many problems in common with space engineering.*

(*Below*) *Steam locomotives offer special difficulties because of the shapes of their boilers. Plastics have made possible the detail on these two 4 mm scale Tri-ang models.*

The process of miniaturisation has spread to all fields of engineering. A very great impetus has been given to it by the increased interest in space flight. Weight and volume are so extremely important in this field that cost must be ignored if half an ounce can be knocked off. Cost is still important for the makers of models though —they have to sell their products to a cost conscious public. But the problems are similar.

Model railways are examples on the engineering side. Lines Brothers make the smallest commercial scale model railway range—the TT3 built to a scale of 3 mm to 1 ft—and so have experienced the problem of getting electric motors into a small space in an acute form. It is interesting to see how their problems line up with those of the makers of space rockets.

Start with size. The interior of a 3 mm Merchant Navy class locomotive offers a space almost exactly ½ in wide by about 2 in long (locomotives with smaller outlines would give even less). Into this has to be fitted the motor and the drive to the wheels.

The motors must be reliable—they will be expected to stand up to shocks far beyond any normally encountered in most engineering practice—and to last for years. They must be self starting: nothing is more annoying than having to push a reluctant locomotive. Equally, nothing could be more disastrous than a motor that failed to function in a rocket. Then, they must be free running. With only 12 volts to play with, and that sadly attenuated by dirty contacts on the track and the amateur wiring, there is very little power to spare and certainly none to be lost needlessly in friction. The same applies to servo motors in rockets: the less power they take the smaller need the batteries be and the longer the useful life expected.

Servicing is essential. The rate at which a model locomotive can pick up fluff has to be experienced to be believed. Therefore it must be possible for the ordinary parent to reach the inside to clean it. So mechanisms are held in by one screw only and the motor held to the locomotive chassis by one screw more. In high class space engineering servicing is usually by replacement—therefore plug-in and single screw fixing units are a *sine qua non*.

The motor evolved for the Tri-ang trains has a sintered magnet with soft iron pole pieces extended to reach over the armature. For self starting a three pole armature is used, wound by hand. The end bearings are fully floating and are made of porous material with pad lubrication. Such a description could be a specification for a servo motor in a rocket.

Toys have become models now; it seems that shortly models will be the real things and the same items at present being used in toys will be fitted in space rockets. The exchange is not one way though; the radio control systems of rockets are rapidly finding their way into toys.

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